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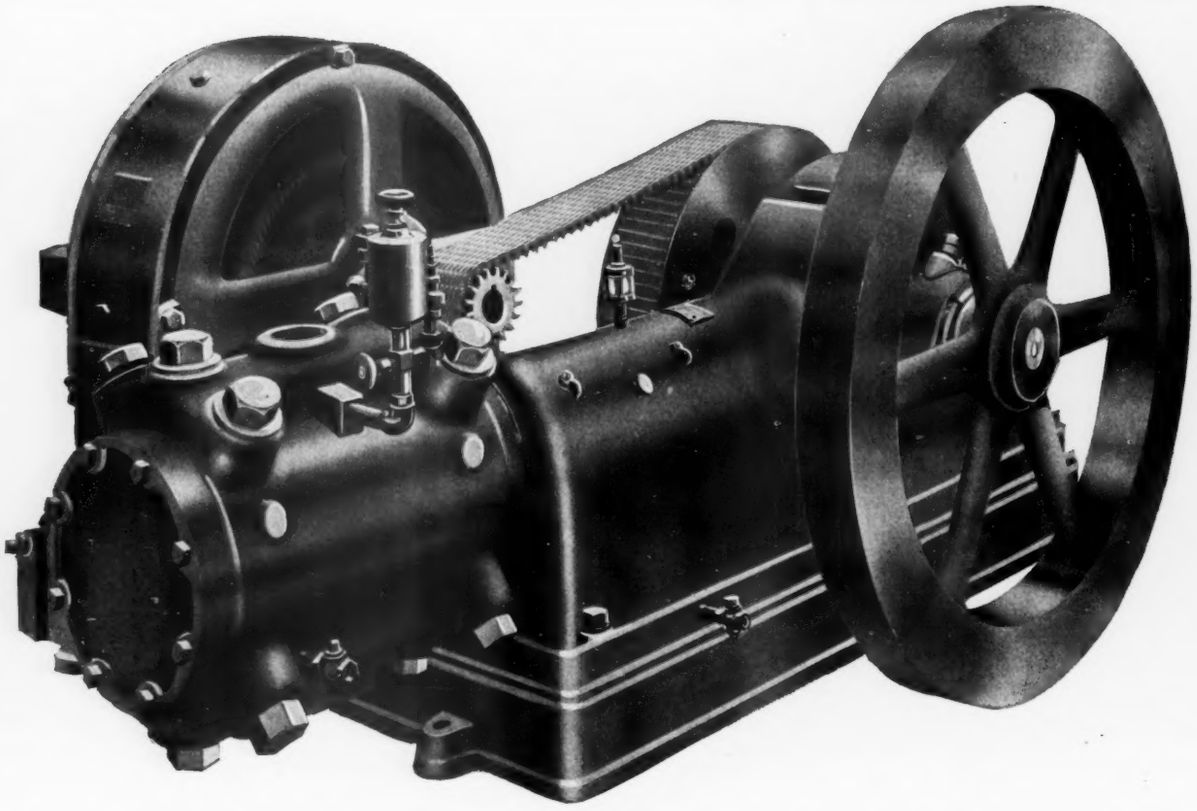

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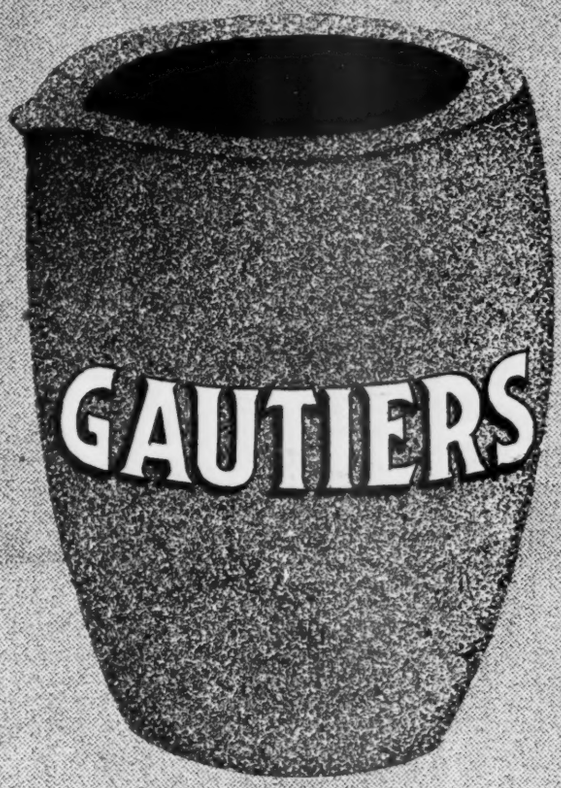

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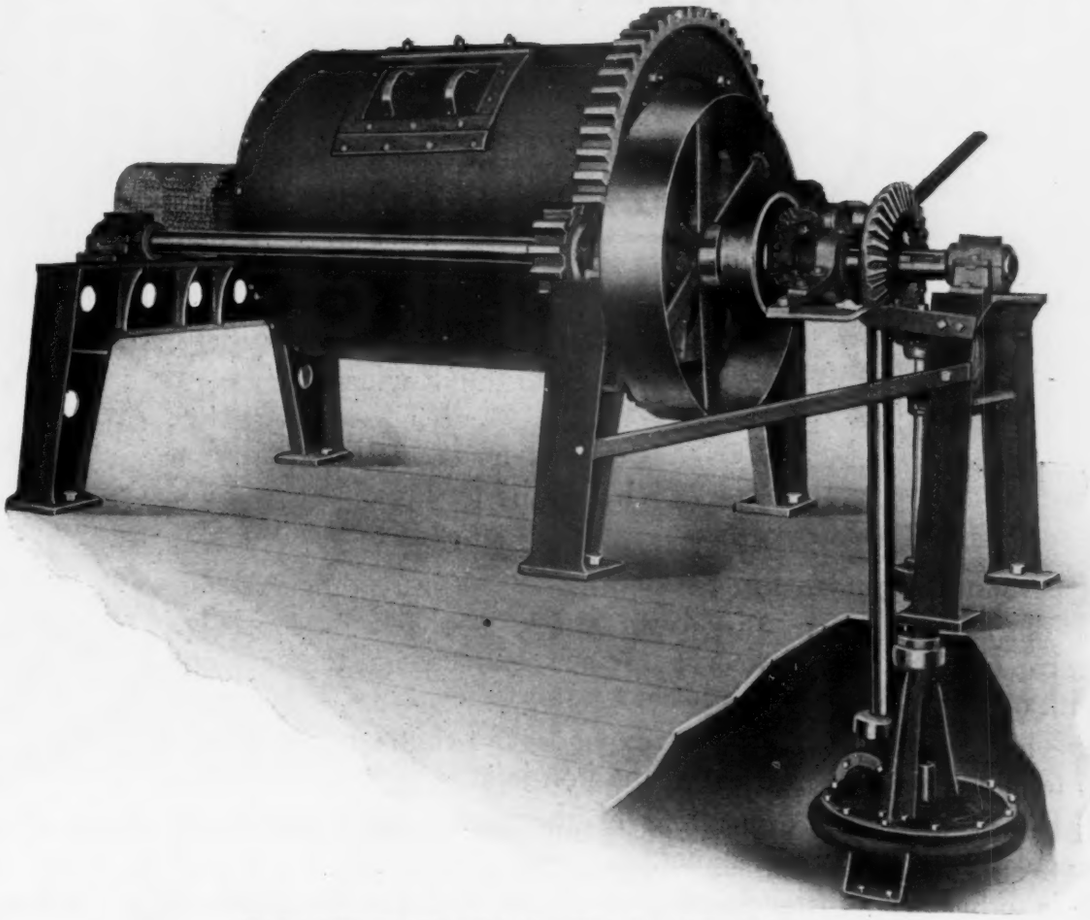

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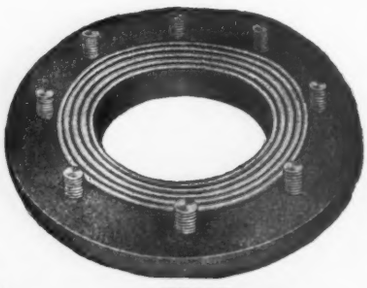

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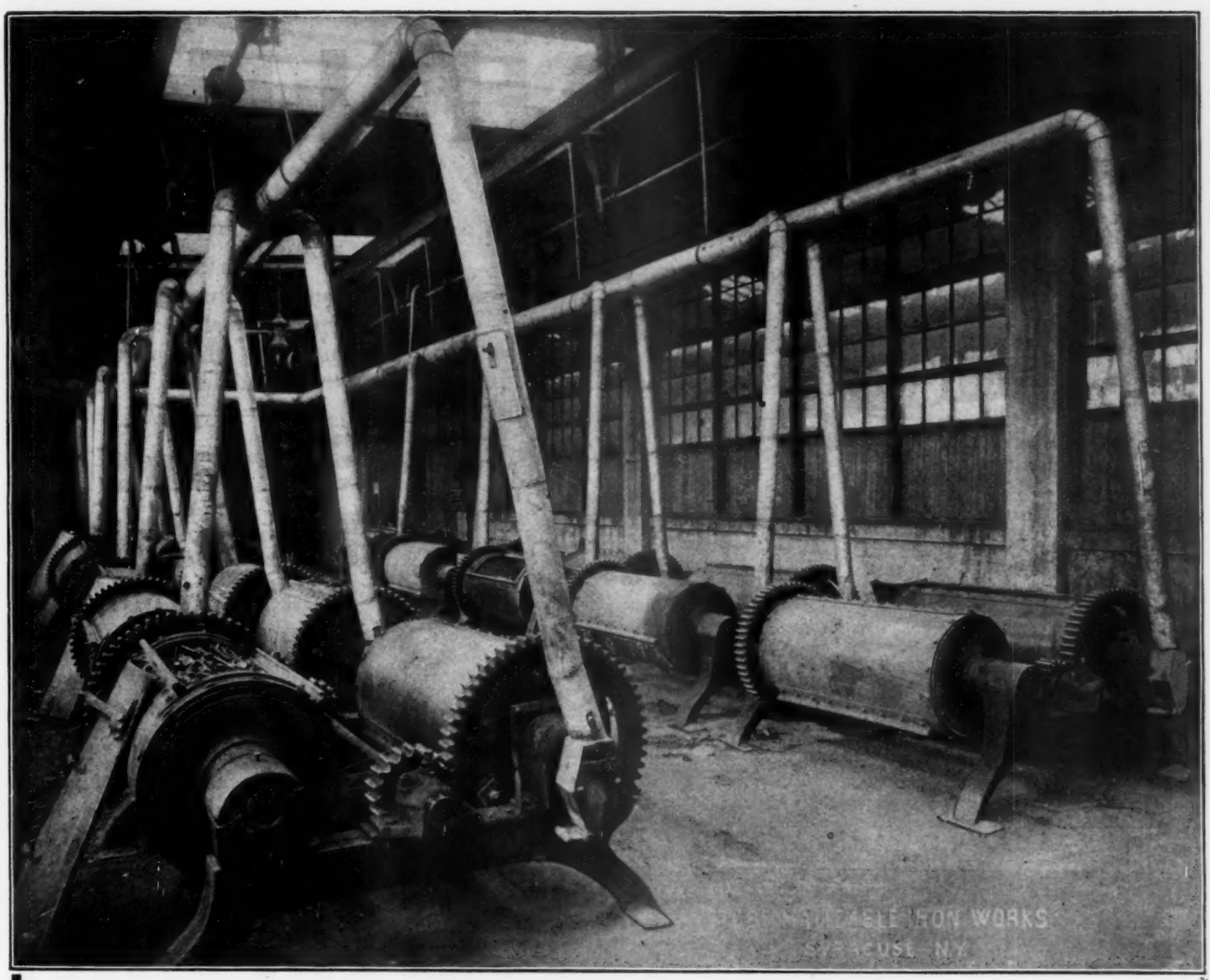

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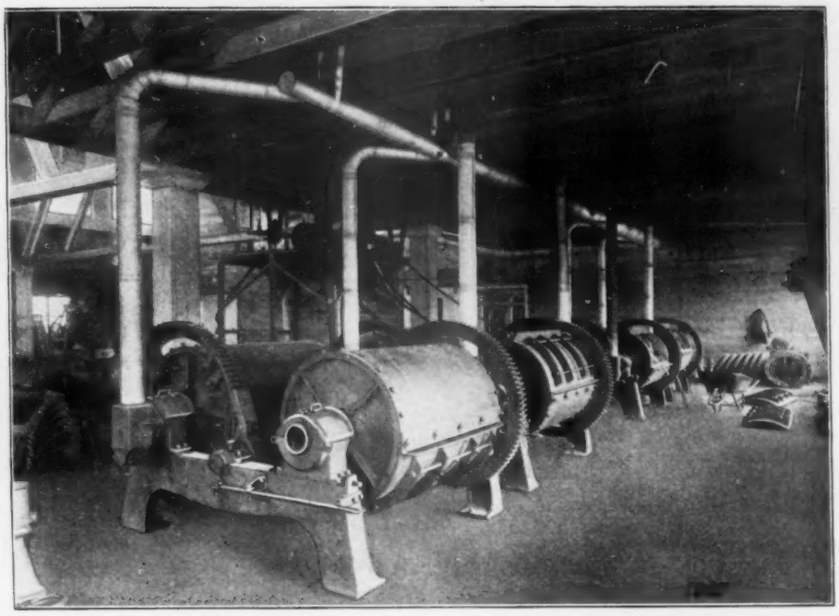

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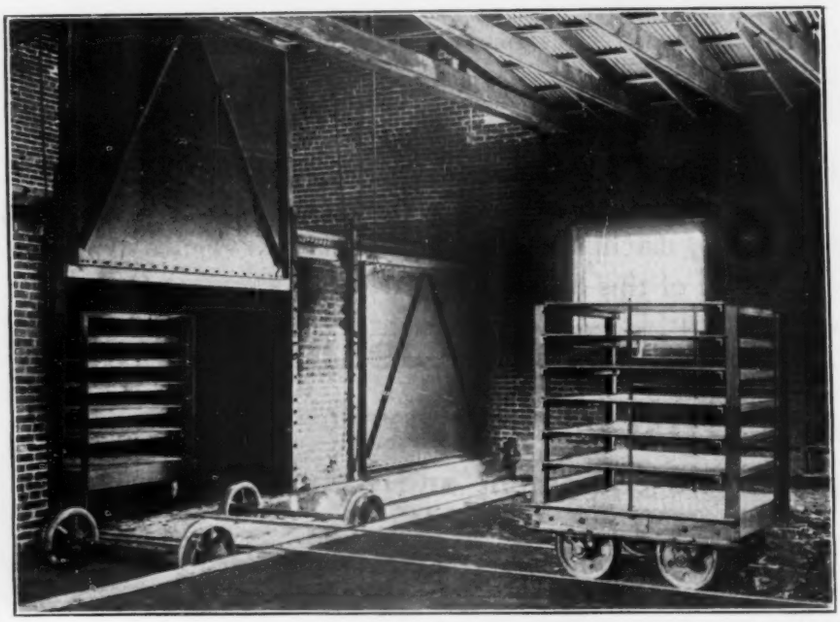

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See Page 103

THE FOUNDRY

Vol. 38, No. 6 Cleveland, Ohio, August, 1911 Whole No. 228

MACHINE-MADE BORING MILL CASTINGS

Method of molding housings, frames and other large machine tool castings on jar-ramming molding machines—Special pattern equipment.

MOLDS for housings, frames and other large machine tool castings formerly molded in pits and on the floor, are now being successfully rammed on jar-ramming molding machines in the foundry operated by the Niles Tool Works Co., Hamilton, O. The equipment consists of a number of plain Norcross jolt-ramming molding machines, as well as one Norcross, three-cylinder machine of 70,000 pounds capacity, installed by the Arcade Mfg. Co., Freeport, Ill. The cost of molding in some instances has been reduced 75 per cent, and to facilitate molding machine operations, all of the patterns have been especially mounted to insure the best possible results.

Tables for standard, 84-inch boring mills are successfully molded in this way. The drag pattern, cope pattern and cope half of the mold for a boring mill table are illustrated in Fig. 2. The drag pattern is mounted on a white pine pattern board, 1½ inches thick, to the back of which is screwed a circular ring or batten, 4 inches wide and 5½ inches thick. To strengthen the bottom board, three transverse battens, 6 inches wide and 5½ inches thick, are attached to the bottom board, as illustrated in Fig. 3. When mounting the pattern on the face of the board, a groove, 1⅜ inches deep, is formed in the top, in which rough-cut boards are fitted flush with the ring. Glued joints on all of the battens and ribs supplement the screws for holding them firmly in position. For drawing the cope pattern, three iron hooks are attached to the cope pattern board to receive the crane hooks, as shown at *B*, Fig. 3. To lift the pattern face up by the crane, three U-plates have been countersunk into the pattern, flush with the surface. These plates are about 4½ inches long and prevent the pattern from being damaged when being lifted. Circular cast iron flasks, strengthened with ribs, are used and the bottom and cope boards are made of cast iron. On the patterns circular guide plates, 2⅛ inches in diameter and ½ inch thick, are set flush with the surface and have a ¾-inch opening in the center which centers with the corresponding opening in the iron flask for the purpose of locating the pattern on the flask and bottom board. Double-headed T-cores, with both

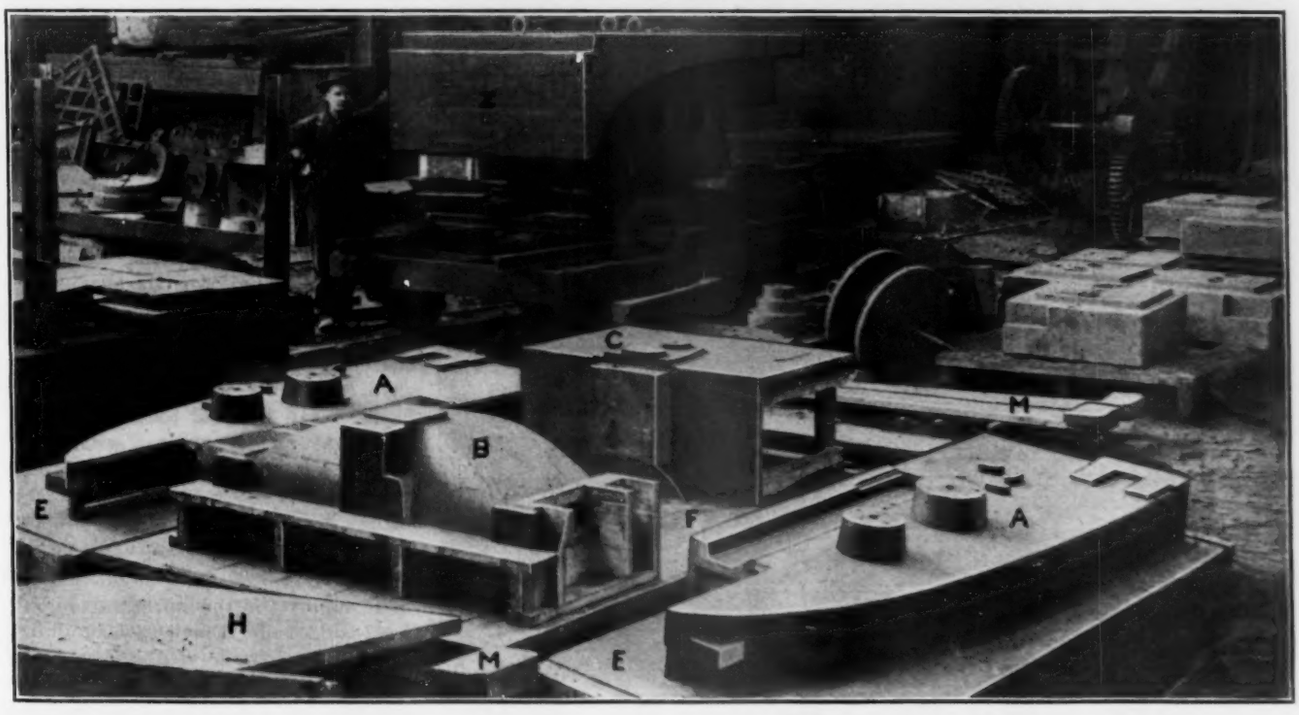


FIG. 1—DETAILS OF CORE BOX FOR THE LARGE MAIN COVER CORE FOR A 42-INCH BORING MILL COLUMN

FIG. 2—DRAG AND COPE PATTERNS AND COPE HALF OF THE MOLD FOR A BORING MILL TABLE RAMMED ON A JOLT-RAMMING MACHINE

heads of equal size, form the slots for the T-bolts in the face of the plate. By using a head of the same size as the bottom, the T-cores are firmly secured and held by slicking down past the top as they are placed. The cope flask has removable iron bars, spaced on 8-inch centers, which extend across the flask, the bars being secured with wooden wedges so that they can be easily removed if the flask is required for other work. Practically all of the flasks used are made of cast iron with removable bars so that they can be easily adapted to other work. Before the installation of the large jolt-ramming machines, this boring mill table was swept up in a pit, the back having been molded entirely with dry sand cores, which required about 22 hours to make. As arranged for jolt-ramming, no cores are required with the exception of the T-cores, which were, of course, used when the mold was swept. The castings, as shown in Fig. 4, weigh approximately 7,000 pounds each, and the two patterns with the bottom boards, 1,800 pounds.

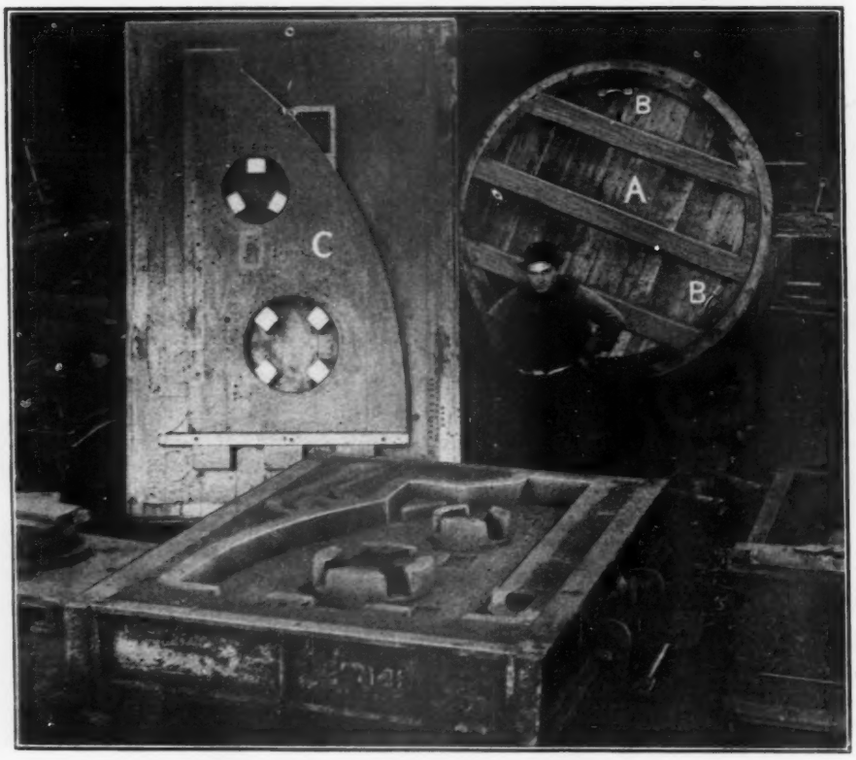


FIG. 3—DRAG PATTERNS FOR AN 84-INCH HOUSING AND DRAG HALF OF THE MOLD IN THE BACKGROUND IS SHOWN THE PATTERN BOARD TO WHICH THE COPE PATTERN OF THE BORING MILL TABLE IS ATTACHED

The upright housings for these boring mills are likewise jolt-rammed from the pattern shown at *C*, Fig. 3. This is the drag pattern and the drag half of the mold is shown in the foreground. The cope half of the mold is merely a covering and contains only about ¾ inch of the thickness of the casting. The drag pattern is mounted on a white pine bottom board which is reinforced with four, 8 x 3½-inch yellow pine battens; a 1-inch strip is placed around the pattern to prevent splitting. No bolts are used to attach the pattern to the bottom board, which is secured entirely by screws. This frame is of the box type and is cored throughout. The drag flask is made of cast iron with the sides bolted to the ends. The bars of the cope flask for this job are removable and when not in use for making housings the flask can be used for other work.

This casting, shown in Fig. 5, after shaking out, weighs 3,800 pounds and the cope and drag patterns with the bottom boards weighs 1,600 pounds. The mold constitutes a day's work for a molder and helper.

The molds for the upright columns of 42-inch and 51-inch boring mills are likewise jolt-rammed. These columns, as illustrated in Fig. 8, comprise the upright, brace and base of the machine, being cast integral, and the casting for the 42-inch mill weighs

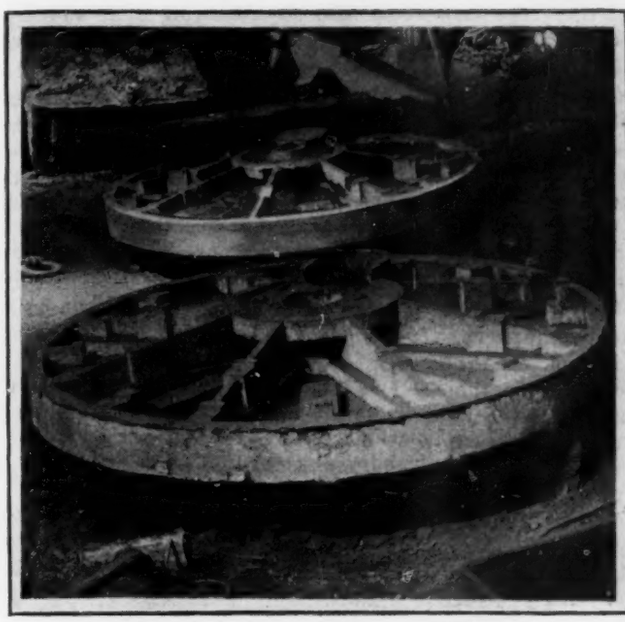


FIG. 4—BORING MILL TABLE CASTINGS AFTER SHAKING OUT

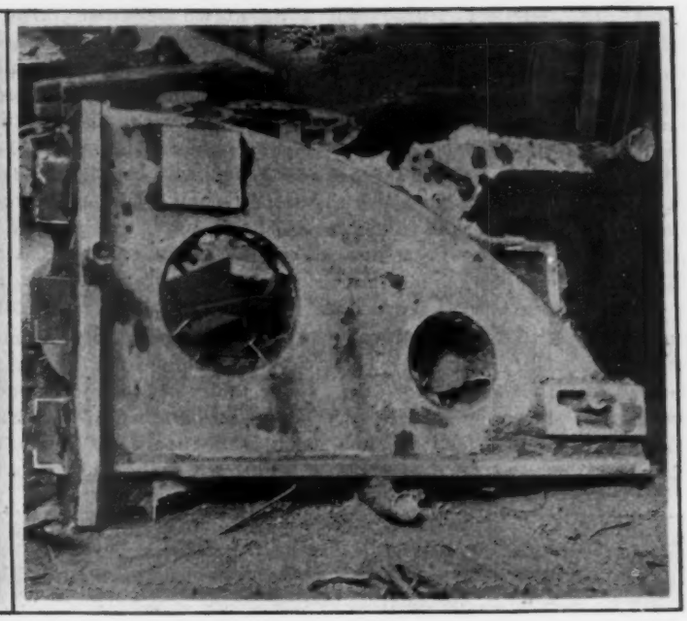


FIG. 5—CASTING OF BORING MILL HOUSING AFTER SHAKING OUT

4,530 pounds and for the 51-inch mill, 6,500 pounds. The 42-inch mill is 7½ feet high and the 51-inch mill 8½ feet high. Prior to the installation of these jolt-ramming machines the patterns were molded in a pit with the mold parted in the center of the openings of the side uprights. One-half of the main core for coring out the inside of the frame was in the drag and the other half was in the cope, thus necessitating the setting of two separate cores. Where the mold was parted, a slight fin was left on a flat surface which was difficult to chip off smoothly and quickly. In arranging this pattern for molding on the jolt-ramming machine it was mounted on a pattern board, 1½ inches thick, as shown in Fig. 9. The pattern board is shown at *A*, and *B* is one of the six 5 x 6-inch battens which are attached crosswise of the board. Around the edge of the bottom board was placed a 1-inch hard wood strip to protect the edges. This strip is removable. The pattern is made of 1½-inch material and is braced throughout. The pattern is attached to the bottom board by three ¾-inch bolts, 12 inches long, which are passed through the braces. The pattern is also held to the bottom board with screws. The entire pattern, with the exception of the bearings, *T*, for the feed boxes, is in one piece. These boxes are drawn into the mold after the pattern has been rammed. The pattern is gated along the upper edge, *E*, to the two corners under the bottom and into the body of the mold at *X*. The flask is shown in Figs. 6 and 7 and is made of two sections securely bolted together and is provided with trunnions and eyes for rolling over.

The main core, which is being lowered into the mold in Fig. 6, is built-up on two core arbors and a bottom board, 2 inches thick. This core also serves as a covering for the mold. On the bottom of this board are cast three double lugs spaced 1¾ inches apart and 2 inches thick with 1½-inch openings through the top. On these lugs are secured three 1¼-inch steel, double end eye bolts, which extend through the core and are flush with the top. When the core is finished the crane hooks are passed through these eye bolts for handling the core. A ribbed, reinforced arbor plate, 8 feet long and 4 ft. 6 inches wide, is used when ramming this core, and the second arbor plate is placed on a level, *M*, Fig. 6. The ribs on the arbor plates are 2 inches wide and 3½ inches high, spaced to 5-inch centers.

With the main cover core, two side

FIG. 6—MOLD FOR BORING MILL COLUMN SHOWING THE COVER CORE BEING LOWERED INTO PLACE

cores are used for coring out the side upright frames, *ZZ*, Fig. 8. These cores are 7 feet 4½ inches long and 2 inches thick, and carry three circular cores, 8¾ inches, 10¼ inches and 11½ inches in diameter, respectively. These cores are attached to the sides of the main body core by bolts, thereby eliminating the difficult setting of these cores necessary when the main cores are hand-rammed on a skeleton core box and are built up on a 9½ x 6 foot bottom board, as shown at *F*, Fig. 1. The core boxes for the cores for the side frames are shown at *A*; *B* forms the core for the spindle end; *C*, the name plate core opening; *EE* are the sides drawn endwise after the core is rammed. Two cleats, 6 feet 2 inches long, with 7 x 12-inch heads, are used to hold the core box together. The core for the 42-inch mill weighs 10,000 pounds and for the 51-inch mill 15,000 pounds. In addition to the main core, a name plate and three spindle cores are used, the spindle cores forming all of the spindle that projects beyond a line drawn across the front faces of the rails of the upright column.

When making this mold the pattern, as shown in Fig. 9, is laid on the table of the jolt machine with the six battens on the base of the bottom board at right angles to two 8 x 8-inch timbers bolted lengthwise above the flask parting line and is held down by three ribbed plates placed crosswise of the mold. One of these molds constitutes a day's work for a molder and helper, the pattern being generally drawn at 11:30 in the morning and the mold is finished at 4:30 in the afternoon. One coremaker makes these cores in from 14 to 16 hours and they are dried at night. The procedure of making these columns consists of finishing the mold one day, setting the cores the following morning and casting the same afternoon. As these columns are for standard sizes of machines they are sent through the foundry in lots of 24 and 48. By

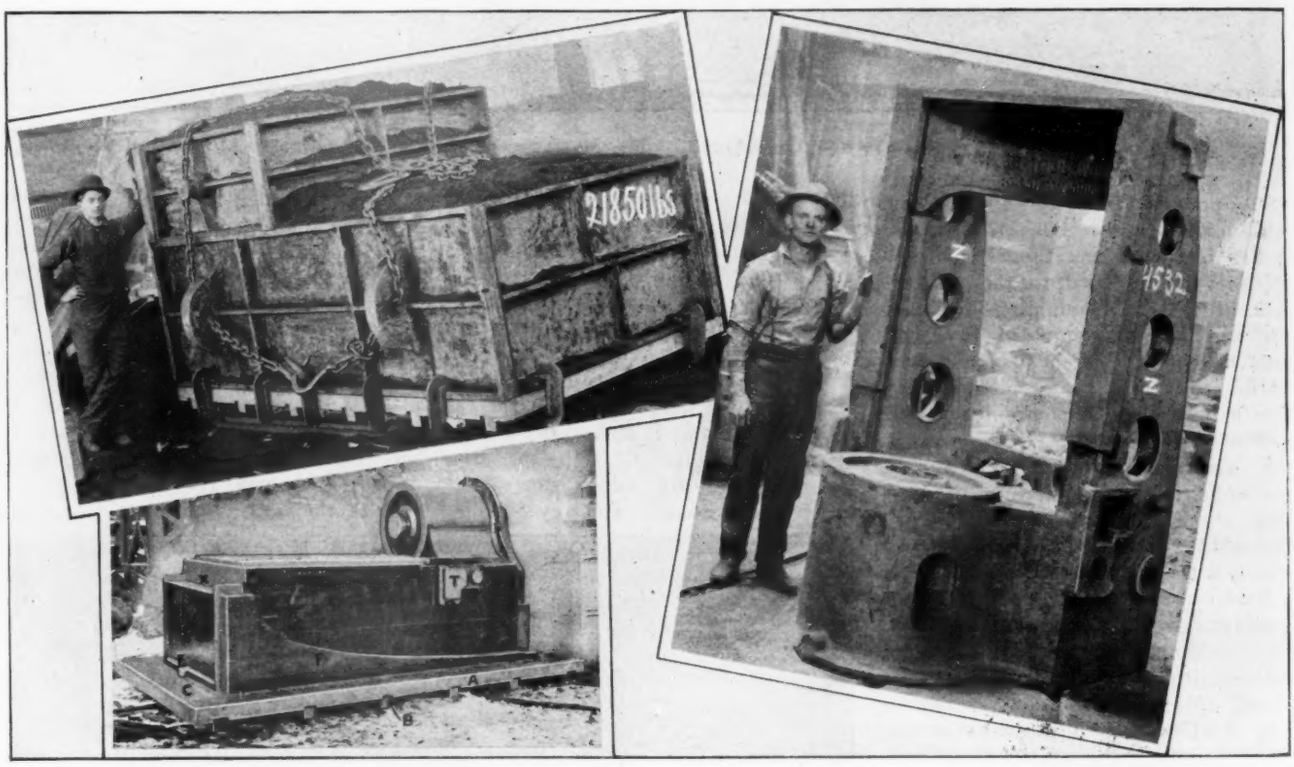


FIG. 7—BORING MILL COLUMN MOLD ON TABLE OF JOLT-RAMMING MACHINE AFTER RAMMING

FIG. 8—A 42-INCH BORING MILL COLUMN, THE MOLD FOR WHICH WAS MADE ON A JOLT-RAMMING MACHINE

FIG. 9—PATTERN FOR BORING MILL COLUMN

of the core box; *H* is the core box end and *M* are the cleats for holding the box together. A square, hollow core, 19½ inches high and 29 inches wide, is used at the upper end of the column to form a space for the name plate core. Two removable side rails, 48 inches long and 10 inches high, form the upright side rails of the main side frame. At the base of the core box a hollow core is used to provide space for placing the spindle which is made separately. Two hollow side frames, 8¼ inches wide, 33½ inches deep and 8 feet 2½ inches long, are used to form the two curved core prints. These side frames are of the jolt machine table. Both battens and timbers are made of yellow pine to prevent unequal wear. The flask is then set over the pattern and clamped, and after being filled with sand is jolted. The mold, after ramming, is shown in Fig. 7. After striking off the mold and attaching the bottom boards, the flask is lifted off the jolt machine by a crane and rolled over. One end of the flask is supported as shown in Fig. 6. The pattern is then drawn by a crane, the mold is skin-dried and after setting the name plate and table cores, the main core is lowered into position. This core projects about 4 inches

the use of the jolt-ramming machines the molding time has been reduced 50 per cent.

The timbers placed on the molding machine tables for supporting flasks of a larger size than the machine tables, are bolted to the tables and are built-up of 2½ x 8-inch yellow pine planks fitted with top pieces, 2 x 8 inches. When these top pieces become worn they can be easily removed and replaced. To prevent the sand from working underneath the machine table a ledge has been built up around the table.

In arranging the patterns for ramming on jolt machines in this foun-

dry, care has been exercised to reduce, as much as possible, the subsequent amount of machine work necessary. Fins on flat surfaces have been entirely eliminated and wherever possible the entire pattern is placed in the drag half of the mold. Many castings that were formerly made in two or more sections are now cast in one piece, thereby eliminating a large amount of machine work. The patterns are all well protected against breakages and wherever possible removable strips are used to permit of replacements when worn. Standard 2⅛-inch pin hole plates are used on all flasks. By this careful arrangement of the patterns not only have economies been effected in the molding cost, but better castings are being obtained by machine molding than were formerly secured when molding by hand.

THE PATTERN SHOP APPRENTICE*

How to teach the apprentice the art of patternmaking---A knowledge of foundry work an essential feature of his training

By Jabez Nall

MAINTAINING the supply of capable all-around mechanics, in any and all lines of handicraft, should be a matter of concern and deep interest to all who are in control of the management of manufacturing establishments. Particularly is this true of the pattern shop and the foundry, which today demand greater skill and more diversified knowledge of the production of castings than ever before. In recent years, the perfection of the molding machine has demanded new ideas in patternmaking, or at least a varied application of old time principles in the art of patternmaking and molding to meet new conditions. In some trades, the machine may have, to some extent, displaced the man or converted him into an automaton, but this is not true of the patternmaker. While the past few years have witnessed some improvement in pattern shop machinery and the introduction of some new labor-saving tools and devices, these merely aid, but in no sense make the patternmaker's work automatic. His efficiency still depends upon his skill as an artisan and his ability to think. I am willing to admit that there are advantages in specializing along certain lines of pattern work to obtain the best results and the patternmaker's special field of endeavor will be developed in large measure by inclination, or by force of circumstance in obtaining employment. The law of the survival of the fittest and the judgment of the foreman also, have a great bearing on the special line of work the patternmaker will follow.

Notwithstanding this specialization of work, which we always find, to some extent, in large shops, it should be our aim, in the education of the pattern shop apprentice, to produce a mechanic capable of doing any kind of pattern work. He should be able to adjust himself to the job in hand and not to waste valuable time and energy producing a piano finish on something not worth while. Nor should he have an exaggerated idea of the importance of the microscopic dimensions required on a few patterns, which, if he attempts to attain on the vast bulk of the work, is wasted effort. However, he should be able to do this when necessary, and to split the hair line when required. While it is to the interest of the manufacturer that the supply of such mechanics shall be large and their ability as great as possible, the question arises whether the manufacturer always takes the best means to attain this end? Does he seek to fulfill his duty to the apprentice, and if so, by what means?

The Manufacturer and the Apprentice.

This, however, is but the obverse side of the argument. There is a reverse side. It is to the interest of the mechanic that the supply of those following his vocation be limited, thereby increasing the demand for his services and insuring a higher remuneration for his work. Is his policy of restriction wise? If so, what are the limitations to be placed on such restriction? Where shall we seek the material for the making of the best mechanics? What system, if any, is best adapted for the fullest development of the material at hand? All of these are questions worthy of consideration, which we will take up briefly in the order named.

Does the manufacturer take the best means to increase the efficiency and supply of good mechanics? It is an admitted fact that he feels the need of a better working force, and deplores the kind of help he is able to obtain. He complains of their inefficiency, as he would have a right to do, were it not for the fact that this condition is the result of an antiquated system of apprenticeship for which he is largely responsible. What opportunity is afforded the boy to learn his trade when placed in the shop without any preliminary knowledge of the requirements of the work he is given to perform? He thus becomes a part of the cheap help of the shop. If he is kept at this kind of work too long, he becomes discouraged and loses all ambition. I do not say that this was the manufacturer's idea of getting cheap help when his superintendent or foreman hired the boy. His mind employed with weightier problems, he has given this little attention or thought, regarding it as the duty of the foreman, perhaps, to attend to the education of the apprentices, and thus dismissed it from his mind.

Under existing conditions, the foreman is too busily engaged attending to the work going through the shop and looking after the men, to devote any time to the special instruction of the apprentices, beyond such general information as he may be able to give the boys with reference to the job in hand, when giving out the work, and a general supervision of the work as it progresses. To teach a boy how to run a lathe, a planer, or any other machine tool does not make him a machinist, nor does teaching a boy how to grind, sharpen and handle his tools, so that he can successfully make a glued joint, turn a piece accurately in the lathe, or carve a block of wood to given lines make him a patternmaker. There is other information that he must acquire. In addition to such knowledge of mechanical drawing as he may be able to acquire in the course of his shop practice, he should be taught the principles of projection, such plane geometry at least, as will enable him to construct his work with a saving of labor and material. He should also have some knowledge of mathematics, and the more of this, the better. It is also essential that he have a knowledge of foundry methods and molding practice. This of itself covers a wide range today. He

*Presented at the Pittsburg convention of the American Foundrymen's Association.

should have other general information pertaining to the trade, such as a partial knowledge, at least, of modern machine shop practice, of the nature and properties of materials that are used, not only in the pattern, but in the finished casting. He should be taught his duties not only as a workman, but as a citizen. This would tend toward the making of the finished mechanic, the betterment of conditions in the shop and an increase in the output. "What is everybody's business is no body's business" is an old saying, and it is nobody's business in the shop with the old-time system of apprenticeship to teach any of the foregoing to the boy.

Municipal School for Apprentices.

Notwithstanding the thorough system outlined, it is frequently impossible to hold some of the boys. They will endeavor to acquire, elsewhere, what they should rightfully receive from the manufacturer, who by contract or otherwise, for a consideration mutually agreed upon, has promised to teach the boy the trade of patternmaking. To acquire this knowledge, the boy devotes four years of his life, at a period best adapted for the purpose, to this line of work. Not to make an effort, at least, to carry out this obligation, is to rob the boy, not of wages due on pay day, but of his chance to advance, and thereby his earning capacity is reduced through life. Some boys will advance in spite of conditions. Others, in order to properly advance, must have both a pull from in front and a boost from behind, and may even then fall back. The apprentice has a right to his chance, however, being willing, according to his ability, to carry out his share of the contract. To expect the small manufacturer to maintain a school for apprentices with a special instructor is not proper, but he can contribute, with others, to the maintenance of such a school in his locality. I believe in the municipal control of these trade schools in preference to state control, and those who benefit most should defray the cost. One thing, at least, the manufacturer can do, even under present conditions, to improve the quality of mechanics and that is to make the pay high enough to attract the bright, brainy boy to the trade.

The Apprentice Ratio.

There is little that can be said regarding efforts by the workman to restrict the number of apprentices in the pattern shop. In my opinion, such an attempt would be foolish because futile. Even with organized labor, a rule that permits only three apprentices to 12 men or four to a shop, cannot be said to be an effort at restriction, as this is about as great a number as the foreman can instruct under present conditions, especially since this is based on the number of men employed in normal times. In dull periods, the percentage is higher, as the force of journeymen is reduced and the apprentices are retained. It has always been the aim of the Patternmakers' Association, so far as I can learn, to help the apprentice become as capable a mechanic as possible, and to this end this organization insists on a rigid adherence to and fulfillment of any contract or indentures that may be binding on the boy. With a view of improving the grade of mechanics, the Cleveland Association of Patternmakers carried on a school for apprentices for some time, presided over by a capable and practiced instructor. This was begun as an experiment and was maintained as long as the attendance warranted its continuance. The school was in session one night a week, but as the boys were compelled to pay a nominal fee for dues, the attendance declined until the school had to be abandoned.

Where Shall Apprentices be Obtained?

Where shall we seek the material for the making of the best mechanics, or in other words, where shall we look for the boy who, by training, will make the best patternmaker? As a matter of fact, it is not necessary to seek, as any establishment employing patternmakers has a waiting list of applicants for apprenticeship. The requirements of the trade are such that they demand, in the successful patternmaker, a high degree of intelligence and power of mental application. This being the case, one naturally seeks the boy whose training and record at school would indicate the possession of this knowledge. Suppose we look over the list in waiting and pick out the boy, who is a high school graduate, or at least had two or three years of high school training. My experience and that of others, with whom I have talked on this subject, show him to be a failure. Why? I am not willing to decry the advantages of education, because I have felt the need of it in my life more than I care to admit, but my experience with this class of boys, shows that they have already been spoiled in the making. Consciously or unconsciously, the teachers seem to have imbued the boys with the idea that they are not only different, but better than the ordinary run of boys that have not had these advantages and that they should not be asked to perform any menial duties. A friend of mine, who has been educating patternmakers for the last 20 years and whose graduates have been remarkably successful, many holding important positions, records as his only failure a high school graduate, who suffered so much from an exaggerated ego that he objected to perform some tasks that the foreman was not above doing himself. Education is a good thing, but the teachers should see that it is practical and coated with common-sense. The boys should not be given the idea that they are the only ones who are fitted for leadership and responsibility and that they must be among the favored few. These boys are not taught how to think for themselves or to apply their knowledge in a practical manner.

Technical School Graduates.

I see no reason why the boy equipped with a higher education should not have a great advantage over the boy who lacks this training, providing this training is practical. If then, we reject the high school boy, who has mastered the classical course, how about the graduate of the technical school? Will he make any better showing? His training has been along special lines and should specially fit him for the work. This, we say, must depend upon the boy. If he only comes into the shop to take a post graduate course and is imbued with the idea that all he needs is a few months' shop experience to fit him for an executive position, I don't want him. If we are to teach trades in school, let it be in the trades school proper, and let the teaching and development be such that a four years' course will place the students at least on an equality with the boy who has had four years of gruelling practice in the shop. For my own part, I prefer, as an apprentice, a healthy boy, of good habits and a fair amount of animal spirit, who, having graduated from the grammar grades, and has had a year or two of shop discipline and experience, has reached the age of about 17 and has fully made up his mind that he wants to be a patternmaker, and the height of whose ambition is to be a good mechanic. With this kind of material to work with, I believe the best of results can be obtained.

This leads to the last question regarding the system best adapted for the highest development of the material at hand. There are many small pattern shops throughout the country, where any special system of instruction or method of procedure in educating the apprentice in the shop is almost an impossibility, because only one or perhaps two are employed. Yet, if a boy is determined to learn and if the foreman is willing to do his part in carrying out the firm's share of the contract, this apprentice may even have the advantage over the boy who serves his time in a larger shop where some sort of system may be in vogue.

Some of our brightest mechanics are graduates of small shops. It is entirely

up to the boy in such a case. If his mind is filled with the thoughts of the pleasure of the previous night, he is not liable to make good. However, if his attention to his work and his disposition is such as to gain the good will and interest of his foreman, his opportunity for individual instruction in a small shop is better than in a large one. Such a boy will usually take advantage of what outside help he can obtain from such educational courses as are offered by such organizations as the Y. M. C. A. and others. These might be considered substitutes for the special municipal trades school that should exist in every community large enough to maintain them. He should also read technical papers and magazines containing articles relating to his trade. These will prove of great value to him, as through them he will obtain a knowledge of the ideas of other men than those with whom he associates daily and he has an opportunity of studying problems that do not come before him in his daily work.

Training Apprentices.

The best that was possible under the old system of apprenticeship, and which, notwithstanding the steady progress in recent years of the advanced or new apprenticeship idea, is still the one under which the majority of the present-day pattern shop apprentices must learn their trade, was the adoption of some method of training in the shop itself, independent of outside help. The plan adopted and practiced by Mr. Walt, of the Cleveland Punch & Shear Works Co., who also handles a large amount of outside pattern work, shows the best results in producing the finished mechanic of any that has come under my personal observation. Whether the success thus attained is due to the system or the man, the results are most creditable. I do not know of any of his graduates that have not made good as patternmakers, and many of them hold positions of responsibility today. His system requires a probationary period of three months, during which time the boy helps wherever possible in lending a hand at sand-papering, varnishing, etc., while he familiarizes himself with his surroundings, the nature of the work and the discipline of the shop. He is given ample opportunity to show what is in him and to make up his mind whether he wants to be a patternmaker or not. On the other hand, the manager of the shop has time to decide whether the boy is fitted for the work. At the end of this period, the parent or guardian of the boy is called in and a contract is entered into covering a period of four years, during which time the boy is to be taught the trade. The contract stipulates the boy's duties, payments at stated periods and the amount of increase in wages.

The shop practice, briefly stated, is to start the apprentice at circular work, simple lathe work, blank gear work, etc. He is given a bench and is expected to provide himself with the necessary tools. This class of work familiarizes him with the use of machinery and different shop tools, which he has been carefully instructed to handle and has been warned of the peculiar dangers of each woodworking tool that might lead to accidents. Having become proficient in this class of work, he is given simple patterns to make requiring bench work and is advanced to better and more intricate work as he shows himself capable to perform it. It has been found that advancing the apprentice as rapidly as is consistent with the thoroughness of his work makes him ambitious to learn and is, in the end, more profitable, than keeping him on class of work that he has learned to perform quickly. This is justice to the boy and discharges the obligation of the firm. Throughout this period of instruction, foundry methods are given due weight and it is to this feature that I attribute the success of this system. In my own personal experience as an instructor of pattern shop apprentices, I have found it most difficult to get the apprentice to take a sufficient interest in the foundry end of this trade. This knowledge is essential to success, as the pattern he makes is but a means to an end and not the end itself. The reason, it seems to me, is due to the boy's wrong conception of the trade in the beginning. In some way he has learned that pattern-making is the best of the woodworking trades, and as he wants to be a woodworker, he does not care to hear much about sand. Sand is dirt, and his preconceived idea of pattern-making was that it was a clean job. When he has to help change some old pattern that has done duty for years, he gets a chance to revise his notions, and he finds sand is an important feature of pattern-making.

Knowledge of Foundry Practice.

It is much easier to train a woodworker capable of completing a model, true to size and shape, without a false cut or scratch to mar its perfection, than to train a patternmaker, who to be proficient, must have some knowledge of machine shop practice and a much more extended knowledge of foundry practice. The up-to-date system of instructing apprentices by means of the apprentice school in connection with the shop is possible only in some of the largest works of the country. This method appeals to me as the ideal. This system, so far as I have been able to learn, has only been applied to the machine shop, and the pattern shop apprentice has been entirely overlooked. I was much impressed with the account of "A German Apprentice School", published in the *American Machinist*. The school was conducted by Ludwig, Loewe & Co., Berlin, Germany. The article was written by Otto Stolzenberg, who devotes his whole time to the work as special instructor. The subjects taught are numerous, but their application practical. The feature affecting the pattern shop apprentice that impressed me most was the fact that "The pattern shop apprentice is required to give six months, or one-sixth of his time as apprentice to foundry work". Wherever this is possible, as in a shop that has its own foundry, it would be wise to follow this practice and to have this feature included in the apprenticeship contract. A six months' course in the foundry I would place as a preliminary to the course in the pattern shop, believing it to be a great advantage. Another feature pointed out in this article was the use made of the magic lantern in the class room. The possibilities of this as a means of instruction in connection with shop work seems to me limitless, as photographs taken in different shops showing different methods of doing the same work or different kinds of work, reduced to lantern slides, present the idea to the student in a form he cannot fail to appreciate and understand.

Trade Schools.

The technical or trade school, apart from regular shop practice, does not appeal to me as capable of producing a mechanic capable of competing with the graduate apprentice of a regular manufacturing establishment and particularly so of the pattern shop. The former is taught under conditions differing too much from the actual conditions he must meet with later. He is brought up as a student among students, with a student's leisure, and if there is competition, it is only against others like himself, but the pattern shop apprentice early realizes that he must compete not only with other apprentices, but with the journeyman patternmaker that may work at the next bench, and if he is ambitious, his aim will be not only to equal, but to excell the best man in the shop.

In a paper read before the Iron and Steel Institute of Great Britain, London, Eng., W. H. Hatfield described a series of experiments on the influence of vanadium on the physical properties of cast iron, from which it was deduced that vanadium has a definite influence upon the properties of cast iron, assisting the carbon to persist in the combined state, and rendering the carbide more stable.

CHARGING CUPOLAS MECHANICALLY*

A discussion of the economies effected by the use of mechanical charging devices — Ideal arrangements of charging floors

By G. R. Brandon

IT IS evident from the interest aroused in methods for reducing the cost of handling cupola stock that this subject is considered of great importance by foundry managers. There is no department in the foundry, in which greater returns will result from the adoption of a scientific plan of operation. Every movement, from the time the stock arrives in the yard until charged into the cupola must be carefully studied, and facilities provided to eliminate manual labor wherever possible and make this labor most effective when necessary to be depended upon.

I will consider first the layout of the storage yard and means for handling the stock. Assuming a foundry of moderate capacity, for which ample ground for an accumulation of stock will be provided, materials should be delivered on cars on a railroad switch track running parallel to the length of the foundry on the side where the cupola house is located. The distance between the foundry building and this track should allow space for storage adjacent to the railroad switch and for a narrow gage yard track between the storage piles and the building. It is evident that the layout of the stock yard will depend upon local conditions, but the principles here given will be applicable in any plant.

Pig iron should be piled in the yard, with a label on each pile, giving brand and grade of iron, also initial and number of car on which the iron was received. A good plan is to mark the pigs near the bottom layer of the pile, which will not be disturbed until the pile is nearly used. From the car records the analyses and complete information regarding the particular carload should be obtainable. Scrap iron is simply dumped into bins, different grades being kept separate. Coke should be stored in covered bins. When the tonnage handled is sufficient to make the investment profitable, a traveling or gantry crane, covering the storage yard, should be installed. It should have high speed movements and should be fitted with a magnet for unloading pig and scrap, and for manipulating a drop weight for breaking the scrap. This crane should also be used for handling heavy flasks in and out of storage, and for loading castings to be shipped. The crane may be fitted with a grab bucket to handle coke and limestone. A jib crane may be substituted for a traveler in a smaller plant and will perform similar functions, to a limited extent.

Disregarding the primitive methods still occasionally employed, of using barrows and dumping stock on the charging floor to be rehandled in making up charges and again for charging into the cupola, I will briefly review various modern methods of handling cupola stock from yard to cupola. Charges should be collected on cars, the proper amount of different grades being selected and weighed and not again handled until introduced into the cupola. Cars of two tons capacity, properly constructed and equipped with roller bearings, can easily be pushed over level tracks by one man. When warranted by conditions, an electrically operated transfer car may be used to transport charging cars while charges are being collected. A scale may be mounted on a transfer to weigh charges, if desired. After the charges are weighed, cars are elevated to the charg-

*Presented at the Pittsburg meeting of the American Foundrymen's Association.

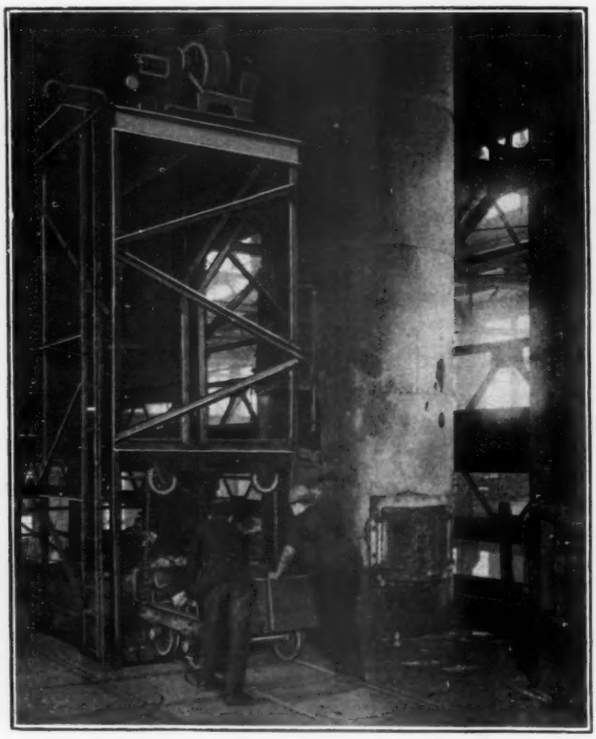


FIG. 1—ELECTRICALLY-DRIVEN CUPOLA CHARGING MACHINE BEFORE CAR IS ELEVATED FOR DUMPING

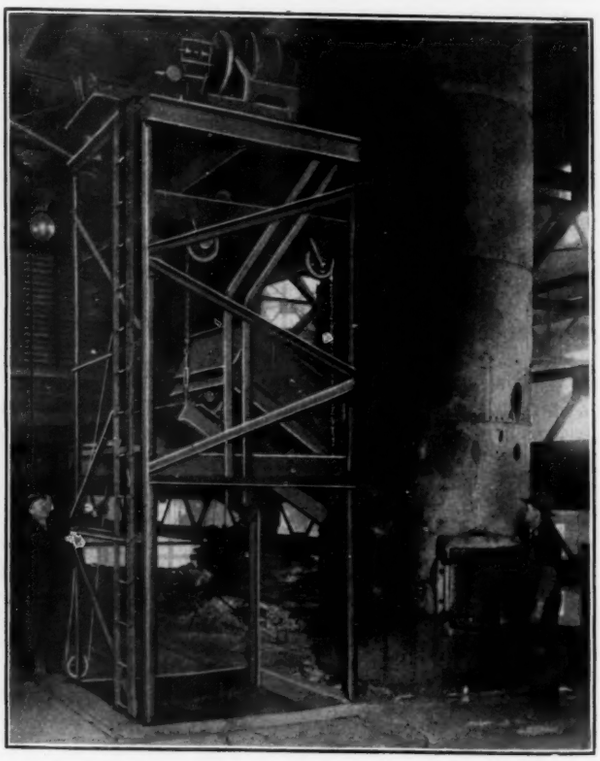


FIG. 2—ELECTRICALLY-DRIVEN CUPOLA CHARGING MACHINE SHOWING CAR ELEVATED AND DUMPING THE CHARGE INTO THE FURNACE

ing platform by means of an elevator, or if the yard crane is available, cars may be constructed with means for attaching slings, and the car with charges lifted intact to the charging floor, but this latter method is not an economical one and is only permissible in case of accident to the elevator. Iron and scrap may be elevated to the charging floor with a magnet crane, but this method requires additional space on the charging floor and involves extra handling.

Storage space for about 50 per cent of the metal for one heat should be provided for on the charging floor and a sufficient number of cars to carry this stock must be supplied for convenience and economical operation. As soon as emptied, cars are lowered to the yard and charges replenished for a later period in the heat. A system of tracks on the charging floor should provide for the constant forward travel of cars and an open track to the elevator for cars that have been unloaded.

If desired, cars may be provided with flat tread wheels, suitable for a plate floor, or with combination wheels, which may be used both on the track and the plate floor. A special design, made by the Whiting Foundry Equipment Co., Harvey, Ill., has a platform overhanging at one end so that when the load is properly adjusted, it will almost balance on one axle. By means of a handle at the other end of the car, it may be readily turned and pushed in any direction. When proper arrangements are made, charges may be dumped into the cupola from this car. It is backed up to the charging door, the wheels are blocked and the forward end is lifted by a suitable hoist. The skip car operating on an incline with automatic dumping device, is also used for charging cupolas.

Trolley Charging Device.

Another device for charging cupolas mechanically, consists of a trolley operating on the jib of a crane or on a track, which extends into the cupola. Charges are made up as desired in a cylindrical bucket, with drop bottom doors, which is carried on this trolley. Hoisting and trolley travel movements are operated by power and the drop doors are opened by releasing a latch.

The Whiting charging machine is used in connection with a simple design of car having steel plate ends, about 12 inches high, for iron charges and is provided with a plate body with a swinging side door, hinged at the top, for coke. On the side dump machines, cars are pushed onto a hinged platform, locked with a simple hook which engages a loop on the car frame, the platform and car are raised together by power, and the charge dumped. The distribution is under the perfect control of the operator, the charges being delivered to the opposite side of the cupola by a sudden, and to the near side by a slow, hoisting movement. End dump machines are supplied when conditions require it, but side dump cars are preferred, as the cars do not have to be turned to place them on the machine. Fig. 6 illustrates an end dump machine.

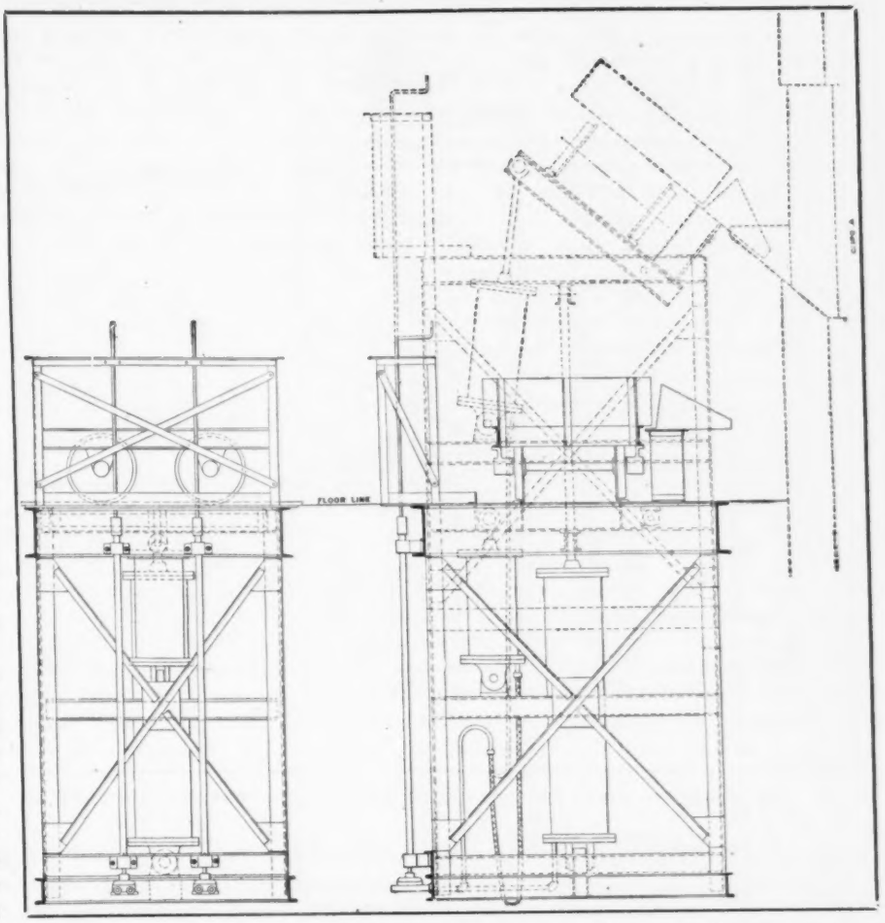


FIG. 3—COMPOUND CUPOLA CHARGING MACHINE IN NORMAL AND DUMPING POSITIONS; POWER IS FURNISHED BY A PNEUMATIC CYLINDER HOIST

Fig. 3 shows a compound charging machine in normal and dumping positions. A pneumatic cylinder hoist furnishes the power for this machine. An electric geared hoist may be substituted for the pneumatic hoist. On the electric compound machine, only one hoisting mechanism is required as the design provides for the inclination of the platform without independent hoist. A crane type of controller is used, which permits wide ranges of speeds and insures a

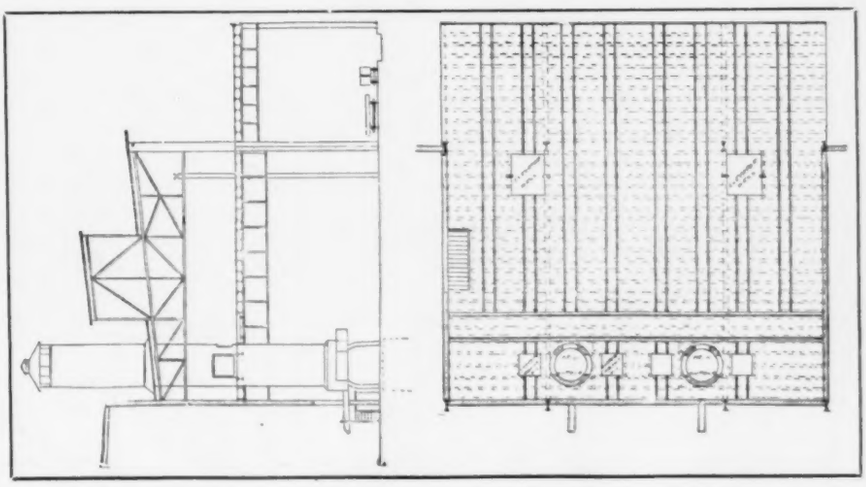


FIG. 4—END ELEVATION AND PLAN VIEW OF CHARGING FLOOR OF THE PENNSYLVANIA GENERAL ELECTRIC CO.'S FOUNDRY

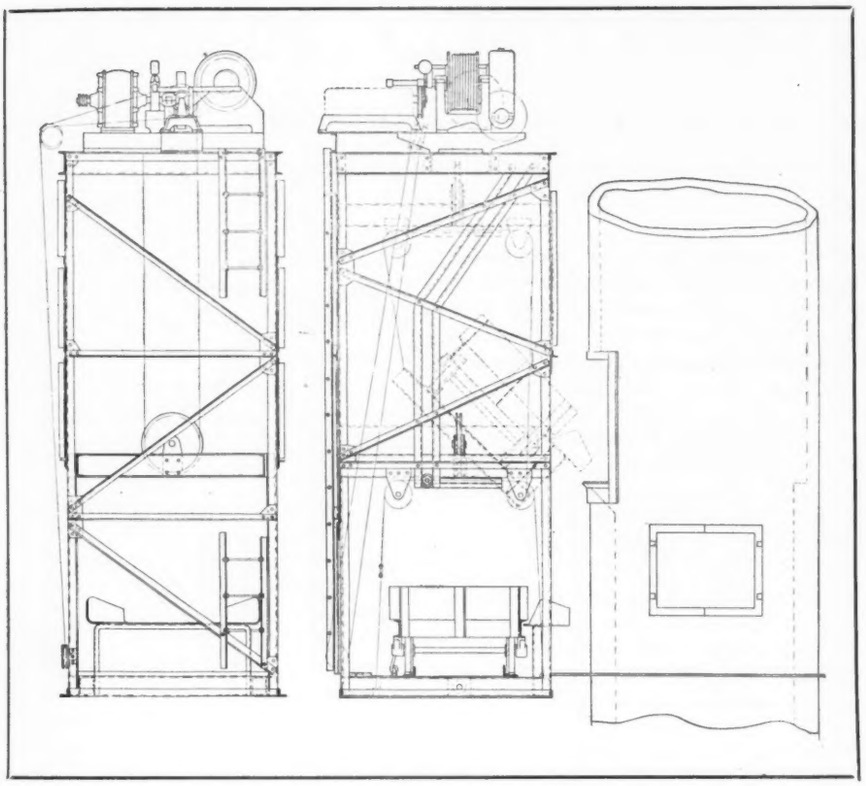


FIG. 5—ELECTRICALLY-DRIVEN, COMPOUND CUPOLA CHARGING MACHINE

uniform distribution of the charges. Fig. 5 shows a side and end elevation of an electric, compound charging machine, and Figs. 1 and 2 show one of these machines installed in the foundry of the Delaware, Lackawanna & Western railroad, at Scranton, Pa. The charging door in the cupola, used in connection with the charging machine is larger than the ordinary door for hand charging and is set lower. An inclined chute is arranged to receive the stock as it is dumped from the car. The charging machine is provided with an apron plate, which overlaps the chute and prevents the iron from dropping from the car to the floor. A vertical distance of four or five feet between the top of the stock in the cupola and the sill of the charging doors is necessary to provide space for the distribution of the charges. Therefore, the charging floors should be higher than when charging is done by hand.

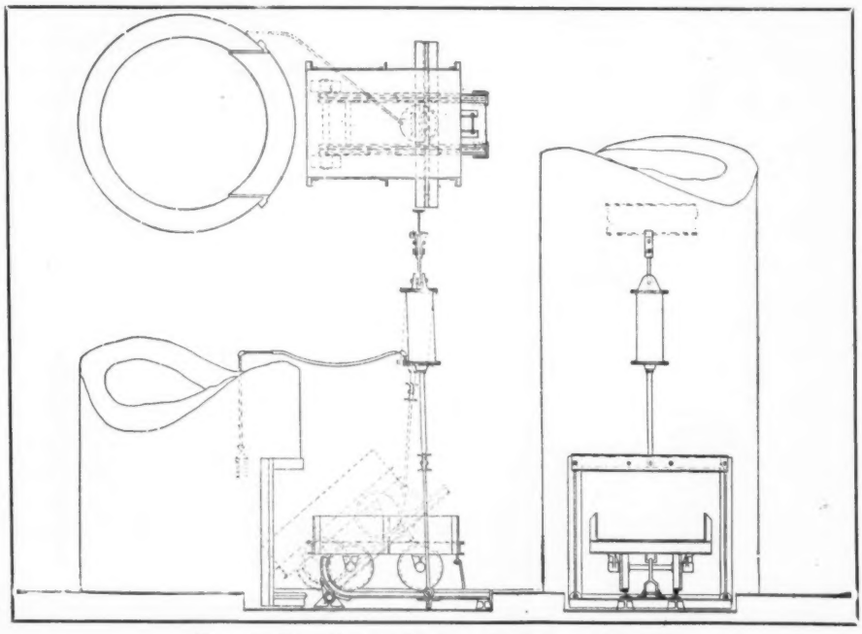


FIG. 6—END DUMP CUPOLA CHARGING MACHINE

These machines have an hourly capacity of 10 to 15 tons or more, the economy of operation increasing as the output per hour increases. For a cupola melting 20 tons per hour, two men with a charging machine attend to all the charging operations, where otherwise five or six men would be required. Another advantage of this machine is that its location is fixed in relation to the charging door and conditions of operation are always uniform. The cost of installation is small, much less in fact than the extra cost of cars with hinged bodies would be for any moderate size plant. Charging cars, only, are required and they are of design that can be used for ordinary hand charging.

The layout of the charging floor, to be installed by the Pennsylvania General Electric Co., Erie, Pa., is shown in Fig. 4. This floor is served both by traveling yard crane and elevators. A transfer car makes connection with all storage tracks and with tracks to the charging machine. Two No. 11 Whiting cupolas, having a capacity of 24 to 27 tons each, will be used, and each cupola will be served by two charging machines.

Malleable Iron Difficulties

By Dr. Richard Moldenke

Question.—We are experiencing difficulty in obtaining malleable iron test bars that will yield a 90-degree bend. The iron is melted by the cupola process.

Answer.—In the absence of information regarding the shape and cross-section of these test bars, it is fair to presume that this foundryman ordinarily gets the 90-degree bend, but is unable to obtain it with the metal in question. Undoubtedly, the metal is being burned in the cupola to sufficient extent to weaken the product considerably, even if it does not affect the fracture and anneals satisfactorily. The solution would be to carefully watch the charging, so that the metal melts continuously in the hottest part of the melting zone and not at either extreme of this section of the furnace. Proper height of fuel bed and small and uniform charges should give hot metal with long life in the ladle, comparatively speaking. Molten iron with little life, which results in short-poured and mis-run work, is an indication of oxidation during the melting operation. It is further assumed that the mixture is right and this can be easily determined by casting test plugs, if desired, or by breaking defective castings as the molds are dumped, during the running of the heat. The iron in this case is first quenched and the fracture observed for excessive mottling. Low iron, treated in this way, will always be weak. It may, further-

more, be presumed that the iron was properly annealed. Iron only slightly burned in melting will not withstand ordinary annealing temperatures without showing it in the fracture. The white rim of blackheart malleable is deeper, with the corners rounded. In the case of whiteheart malleable, the crystallization will be coarser in the corresponding portion of the fracture. With increased oxidation, this inability to withstand the anneal becomes more marked and very poor results are obtained. In works practice, where a variety of heats is represented regularly in the same annealing pot, it can be noted easily whether some metal has been oxidized in melting, inasmuch as when the castings are dumped, the same pot will yield good and bad fractures. It is, therefore, good practice to preserve test bars from the several heats in large racks, showing the date when cast and furnace number, or in the case of cupola metal, these bars should represent the several parts of the day's melt. The bars of several heats in the same pot, placed presumably in the center of the oven and in the middle pot of the sagger, will get the same anneal, and if run properly, a good metal should show up well in fracture, bending and color appearance. If some of the bars are good, the anneal for all was correct, but if the annealing was done improperly, all bars will be bad. Making malleable requires eternal vigilance, but the most important step in this process, is to obtain sound iron from the cupola or furnace. If this is not done, the remainder of the necessary manipulations, will, of course, be wasted.

Dull Iron

By W. J. Keep

Question:—After the first two or three charges the iron from our cupola begins to cool and comes dirty. We light the fire about 12 o'clock and the bed consists of 1,000 pounds of coal and 200 pounds of coke and reaches to a point about 20 inches above the tuyeres. At 1 o'clock we begin charging the iron, scrap, etc., and at 1:45 we shut off the draft and hold the fire back until the blast is put on at 3 o'clock. Our total melt is 5½ tons, which is run off in one hour, and the melting ratio is 5.8 to 1.

Answer:—Light the fire at 12:30 and if the iron comes hot light it at 12:45, and if still hot defer lighting the fire until 1 o'clock. Begin charging at 2 o'clock. You must light your fire early enough to raise the temperature of the cupola bottom and lining to a melting heat, but you can do this in two hours. Use 800 pounds of coal on the bed and charge 200 pounds of coal and 200 pounds of coke just before charging the iron. Your trouble is that your bed burns out before you put on the blast and the melting zone is too low in your cupola during the latter part of the heat. It may be necessary to increase your coke during the last charges. Your ratio of bed to first charge is 1 to 2.8, but 1 to 2.2 is approximately right. The ratio of your other charges is 1 to 11, 1 to 10 and 1 to 14, which is about as close as you can run. It might be better to make these ratios 1 to 11, 1 to 11 and 1 to 12.

Patternmaking and Pattern Equipment—I.*

By W. S. Giele

THE scope of this subject is so broad that, within the limits of the time allowed for its preparation and presentation, it would not be possible to go into detail in any of the many ramifications into which its study might lead. There has, therefore, been no attempt to go into such detail and many of the very important branches have not been mentioned at all. The object has been rather to discover, if possible, such fundamental principles and tendencies of development as will be of general application. The larger problem of economic and efficient equipment subdivides itself into secondary problems as applying to a particular case. Each of these secondary problems finds its solution developed to the highest degree, if not to the ultimate ideal, in specialized industries, in which it happens to be predominant. Advance must come through the general application of these specialized developments.

With the above in mind, a number of specialty foundries have been visited and manufacturers of equipment consulted, the secondary subjects being treated with a view to bringing out, as far as possible, the general application of the special solutions.

*Presented at the Pittsburg convention of the American Foundrymen's Association.

If there is one tendency predominating all others, it would seem to be in the growing substitution of mechanical for manual operations, both in the construction and in the use of the pattern equipment and such tendency, if it is to continue, must take the form of adaptation of the mechanical processes and machines involved, to the requirements. This adaptation is best illustrated by recent developments in woodworking machinery, paralleling contemporary developments in machine tools with such modifications as are required for woodworking processes.

Another example is in the development of simple, economical and rapid methods of mounting patterns for use on molding machines so that the machine becomes available for the production of castings required in comparatively small numbers, as well as for production of large numbers of castings from expensive and highly developed pattern equipments.

Stoves.

The making of stoves presents several striking and characteristic features as distinguished from other branches of the foundry art. The castings are assembled or mounted without having machine work done on them so that while accuracy of size and shape is not important in the finished structure as a whole, accuracy of fit between parts is absolutely essential. In fact, it would be impossible to build up the stove if the fits between castings did not make such close joints that they could easily be sealed air tight and also make a good appearance.

The requirements, peculiar to this industry, have developed methods which do not rely on any abstruse theories nor on scientific accuracy of measurement, but which depend on common sense and care in execution. The basic principle may, perhaps, be said to be the combination of a highly trained eye with the judgment which cannot be embodied in rules, but which comes only from experience.

The author found at one large eastern stove concern that, given the requirements for a new *piece of goods*, the designer, or perhaps more properly the *architect*, first constructed a mental image of what was wanted, and then, bearing in mind the types and patterns on hand, gave it tangible form, sometimes in a clay model and sometimes as a sketch drawn in perspective and shaded, a picture rather than a drawing.

After this had been thoroughly discussed and made to embody suggestions from all departments (co-operation is

a real force in this plant), it was laid down on a full size drawing showing all parts and *not dimensioned.*

Stove Patterns.

The drawing then goes to a gang of patternmakers, who make the master patterns, taking their sizes direct from the drawing. For convenience of distribution to the workmen, comprising the gang, the separate details may be traced from the general drawing. As the castings are very thin, the wood patterns are of course extremely delicate and the methods which are familiar to the stove man are a revelation to many a foundryman in other lines.

For instance, curved pieces are occasionally bent to shape with an expenditure of labor and material but a small fraction of that required to build-up and work out such a piece. Possibly. such patterns would not be very durable under ordinary molding conditions, but in this case they are follow-boarded and used only in the production of working patterns of metal.

Another interesting feature is the production of such irregular shapes as a stove foot, for instance. This compound curved surface, with not a point to measure from, would defy the ingenuity of many a mathematician, but many stove foundrymen have seen the wood carver in a stove pattern shop produce such a piece with apparent ease, working out the exterior surface first, then drawing in the scrolls or other design, curved lines on curved surfaces, and carving them out. And he depends on the eye and on the hand for symmetry.

Thin Castings.

Few foundrymen have not had difficulties with castings of uneven thickness and the importance of this is nowhere more vital than in castings which average less than 1/8 inch in section. Here again the stove foundryman relies on positive common sense methods rather than on refined measurements. Thus, the leg referred to, after the outside has been shaped and carved, is cut away at the back following every irregularity of the design and keeping the metal thickness constant by gaging at every point by means of the well-known tool sometimes called scissors calipers. Even in the case of a gas stove burner the half pattern is shaped inside and out to a constant thickness of metal. Working patterns made from the outside and working core boxes made from the inside of such a master by molding processes will insure castings of uniform thickness.

On this general class of patterns follow boards are not only required to form the parting in the mold, but are essential to support the pattern against springing during ramming. It is often convenient to carry the construction of the follow board along with the construction of the pattern, using it as a support for the pattern when working on the exposed side.

In stoves, as well as in other lines, where one design runs through a line of sizes, great economies can be effected by standardization of elements, any one of which may be used in a number of different sizes and even in the standardization of pattern elements. Standardization of core prints is too obvious to deserve mention, but other elements can be treated in a similar manner.

For instance, the author saw a master pattern for an oven door with expensive carved flanges and corners made with two lines of division at right angles to each other so that it could be extended in both length and width. This one master was used to make a number of working patterns of different sizes and uniform design. The advantage of the follow board support in the case of this divided pattern is self-evident.

Shrinkage Allowances.

Shrinkage allowances are adjusted to the number of steps and kinds of materials intervening between the original pattern and the finished casting. Thus, in the case of the oven door cited, a master pattern is cast each time the original wood pattern is changed and the working patterns cast from these. The original masters are not always made in wood. They are sometimes made in very soft metal, which can be shaped by hand and melted down so that the material can be used over after the secondary master pattern has been cast.

Once the master patterns are completed they are assembled into a model stove, the simplest and quickest method for checking all dimensions. The working patterns are probably most frequently of iron, though also made of aluminum, white alloys and brass, the choice of material being governed by exactly the same considerations that would apply in any foundry.

The foreman of the pattern shop is properly held responsible for the quality of the patterns and, therefore, properly the one to pass on the quality of the castings for working patterns. The castings are sand-blasted and then pickled to remove the scale, after which they may receive a preliminary polishing on a wire wheel brush for irregular surfaces and an emery wheel for flat or convex surfaces.

The main work, however, is done by hand with a file, scraper and emery cloth, and no man who has ever tried to mold a pattern in dry sand will deny that too much care cannot be given to finish and particularly to draft.

Working Patterns.

The working patterns, like the master patterns, are checked by being mounted as the castings are to be, rather than by measurement, and in this final fitting, judgment and experience count for more than theory in deciding just how much allowance should be made for the casting operation. Thus, the cope side will not be rapped, the drag side will, more allowance must be made in shoulders on the drag side than on the cope side. The final test is a sample set of castings made from the patterns and assembled into a stove.

This is a very general view of the method of developing an equipment of patterns for making stoves as practiced in the manufacture of heating and cooking stoves, gas stoves, steam and hot water boilers. The patterns for small parts particularly, and for some of the large parts, as well, are mounted on plates or fitted with stripping plates for use on the molding machine.

Gating on these thin castings is important, as the gates must be of ample area to flow the metal over the whole of the mold without the formation of cold shuts and thin enough to break off without breaking into the casting. The use of set gates or gates permanently attached to the patterns is preferred to gates cut by the molder, which are never twice alike.

THE FOUNDRY, April 1909, contained an article entitled "Hinged Matchplates for Stove Work," which described the method followed by the Buck's Stove & Range Co., St. Louis. The alloy for the matchplates was zinc 1 and aluminum 2. This alloy withstands severe foundry usage without being broken or bent. It has a high shrinkage and in order to get it into the mold as quickly as possible, it is poured simultaneously from four generous sprues and a large riser is usually placed in the center of the mold. Other articles on stove plate work were also published in THE FOUNDRY in March and June, 1910.

Pattern Shop Arrangement.

The equipment of the shop for making the patterns is interesting as well as the process. Mr. Whitehead, superintendent of the pattern shop of the Abram Cox Stove Co., Philadelphia, has made a very effective arrangement in that plant by placing all the benches with their left ends toward the windows, thus economizing space, giving

each man the best possible light and easiest access to machines and lessening the temptation to conversation between the workmen, because each looks toward his neighbor's back. The machinery is advantageously placed in a line paralleling the line of benches and near the center of the shop. The usual woodworking tools are provided. One tool which should be found in every shop is a first class grinding machine for sharpening tools, carrying a revolving oil stone and a cone-shaped stone for gouges. Another in the same class is a small jointer taking such pieces as are usually planed by hand. The knives of such a machine are much more easily kept in perfect shape than on a larger machine and it is a time-saver on work within its range.

Another time-saver is a rack containing, in marked compartments, perfectly seasoned and accurately planed stock in thicknesses of 8, 9, 10, 11, 12, 13, 14 and 15 to the inch. The varnishing is confined to a room provided for the purpose. The metal workers are provided with convenient motor-driven grinding stands carrying emery wheels and wire brushes that save much hand work. There is also a small, portable, electric drill which can be attached to any lamp socket and taken to the work at the bench or vise.

The soldering forges are gas fired in this shop and are arranged with a pilot light and automatic valve, the latter being operated by the weight of the soldering copper when it is laid into the forge.

The metal workers are provided with a small molding department in which the alloy patterns and pattern plates are cast and in which the actual working of a pattern in the sand can be conveniently tested. This department contains the furnaces for melting the pig metals from which the alloys are made.

The lessons to be drawn from the general methods outlined as applicable to other branches of the art might be summarized as follows:

1.—Starting with a definite notion of size and saving the time consumed in laying out a piece to scale and then laying it out again full size in the shop.

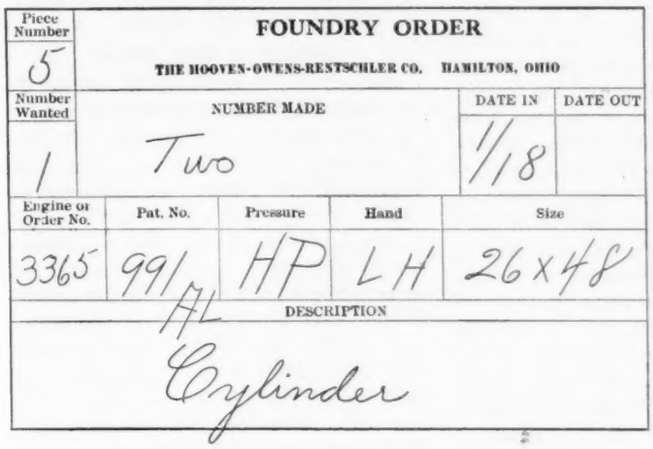
2.—Saving in time required to dimension drawing and complication of drawing by dimension lines and figures.

3.—Elimination of mistakes in putting down and reading dimensions.

4.—Saving filing and reference systems. Each piece given a number and the master or secondary master pattern giving an absolutely sure record of the piece. This method makes it possible to furnish repairs for stoves made 50 years ago.

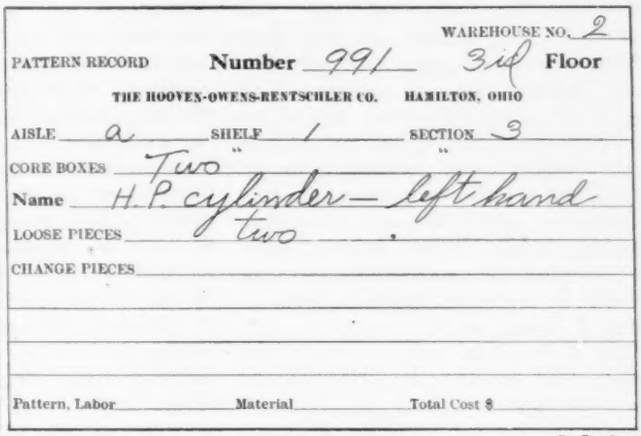
5.—Absolute checking of dimensions without possibility of errors in measuring by assembling patterns.

6.—Concrete idea of appearance of finished product, before it is made, through assembled patterns.



Piece Number	FOUNDRY ORDER			
5	THE HOOVEN-OWENS-RENTSCHLER CO. HAMILTON, OHIO			
Number Wanted	NUMBER MADE		DATE IN	DATE OUT
1	Two		1/18	
Engine or Order No.	Pat. No.	Pressure	Hand	Size
3365	991 H.L	HP	LH	26x48
DESCRIPTION				
Cylinder				

FIG. 1—FOUNDRY ORDER CARD



WAREHOUSE NO. 2

PATTERN RECORD Number 991 3rd Floor

THE HOOVEN-OWENS-RENTSCHLER CO. HAMILTON, OHIO

AISLE a SHELF 1 SECTION 3

CORE BOXES Two " "

Name H.P. cylinder—left hand

LOOSE PIECES two

CHANGE PIECES

Pattern, Labor Material Total Cost $

The Foundry

FIG. 2—PATTERN RECORD CARD

A Simple Pattern Record System

By J. A. Murphy.

A simple system for recording patterns has been devised for use in a foundry where a large number of patterns for engines of different types and sizes are used. When an order for machinery is received, blue prints are sent from the office to the shop showing the various parts required, and containing particulars as to the number of castings required and the size to which they must be machined. From these blue prints the foundry order, Fig. 1, is filled out in duplicate. This order contains the piece number, the pattern number, the order or engine number, shows how many castings are required, and gives a description of the pattern and its size. The duplicate of this order is sent to the pattern shop and the original is retained in the foundry office until the casting is made. The duplicate foundry order card is attached to the pattern when it reaches the pattern shop, and on the arrival of the pattern in the foundry the card is removed by the man in charge of the job, who retains it until the casting is made. On large jobs, he records on the card the time spent on the work, and then delivers it to the foundry office where it is accepted as proof that the casting has been made. When the casting is shipped to the machine shop, the card goes with it and is filed permanently in the office of the machine shop, while the original is retained in the foundry office. When the pattern is returned to the pattern shop, it is stored in its proper place, and the pattern record card, Fig. 2, is made out and filed. The original foundry order card, when first received, is filed in the foundry office in a card index file, where it remains during the time the work is going forward, thus, when a new job is received the index file contains the order cards for all the castings required, and as the work proceeds, the file of cards constantly diminishes as the duplicates are permanently filed away. The clerk in the foundry office can thus note at a glance just what castings, and how many of each still remain to be made before the order is completed.

J. M. Betton, New York City, manufacturer of the Drucklieb injector sand blast apparatus, has removed from 178 Washington street to 14 Park place.

THE BRASS FOUNDRY

Silicon in Non-Ferrous Alloys

By C. Vickers

SILICON was one of the first of the modern deoxidizing agents placed at the disposal of the brass founder, and its introduction has been of great advantage in electrical engineering, as its use has enabled much higher conductivities to be obtained in copper castings than was formerly possible. This is due to the fact that a relatively small amount of silicon will eliminate blow-holes in copper castings. The metal is not changed to any great extent, but retains the color and general characteristics of copper. Zinc, when used as a deoxidizer, necessitates the addition of several per cent to copper to obtain solid castings, with the result that an alloy is formed, the conductivity of which is much lower than that of copper. Silicon, however, does not improve the conductivity of copper, as it unites therewith to form an alloy, the same as zinc, and if it were added in the same quantity, would also reduce the conductivity. It follows, therefore, that an excess of silicon is undesirable in castings for electrical purposes, and it has been found that the highest results are only obtained when the minimum quantity of silicon that will reduce the oxide in the metal, is used. This quantity varies considerably, because the amount of oxide in the copper is subject to wide variations, which are dependent on the purity of the copper, and the manner in which it is melted. Consequently, the greater the degree of purity of the copper used, and the more carefully it is protected from oxidation while in the furnace, the smaller will be the amount of silicon necessary to insure perfect castings, and the higher will be their conductivity.

Melting the Copper.

Even with the greatest care, the copper will be oxidized to some extent while melting. Therefore, the molten copper differs from the original ingot by the amount of oxide it contains, so that it will require more silicon to make sound castings than if it had remained at the tough-pitch condition of the ingot. Therefore, it would seem that it would be advantageous to change the copper, when melted, back to the tough-pitch condition before additions of silicon are made. This has been found to be the case, and the amount of 10 per cent silicon-copper required to eliminate blow-holes in sand castings poured from tough-pitch copper is less than 0.25 per cent. It has been determined by experiment that this quantity of silicon-copper will insure solid castings, even when the copper is not poled, and only careful attention is given to the melting. Therefore, a smaller amount of silicon-copper should do the work in conjunction with the poling process.

As the conductivity of copper, to which 1 per cent of silicon-copper has been added, is only about 57 per cent, there is room for improvement, and care in melting should be exercised to protect the metal from oxidation, so that as little silicon as possible can be used in making the castings. When this is accomplished, the amount of silicon added to the copper is very small, only 0.025 per cent, and the percentage remaining in the metal is much less than this, as the greater portion is undoubtedly fluxed out. Consequently, the purity and conductivity of such castings is very little less than that of the pure metal itself.

Silicon as a Hardener of Copper.

Silicon is a great hardener of copper, being superior to tin in this respect, as the 10 per cent alloy of silicon and copper is so brittle that it can be shattered like glass, an effect that would require over three times the amount of tin to produce. When present in small quantity, however, the effect of silicon in copper is to soften it, and castings made with silicon are as soft as annealed copper, a condition that is not appreciably changed, even when the content of silicon reaches 1 per cent. An alloy of copper, 90 per cent, and silicon-copper, 10 per cent, casts solid and clean, has a fibrous fracture of light, salmon color, and the metal is soft and does not greatly differ from copper, to which only 2 per cent of silicon-copper has been added. The actual amount of silicon in the so-called 10 per cent silicon-copper is only 9.63 per cent by analysis, although this may, of course, vary, according to the conditions prevailing when the alloy is made. The principal use of silicon-copper in the past has been to insure the production of solid copper castings, but further than this it has not been extensively used in brass foundries. A number of experiments, however, have been undertaken with a view of determining its usefulness as an addition to other metals.

Silicon in Red Brass.

One of the first alloys in which silicon was tried was made by the following formula: Copper, 86 per cent; tin, 8 per cent; zinc, 4 per cent, and lead, 2 per cent. A sufficient amount to make a few castings was re-melted. The silicon was added in the form of silicon-copper and the amount used was equal to an addition of 4 pounds to 100 pounds of the mixture. One-half of the metal was poured into ingots, and one-half into sand molds. The ingots were of good appearance, smooth on top, with a depression extending lengthwise down the center, the bottom of the ingot being red and gold in color. The sand castings were exceedingly dirty and were covered with a white coating. The metal underneath the surface was spongy, the holes being filled with the white substance. The fracture of the metal was inclined to be crystalline, with large tearing crystals of a yellowish red hue, and the castings had to be scrapped. The alloy was remelted and cast a second time with no visible improvement in the sand castings, although the ingots were satisfactory in appearance. The fracture of the metal was dense and of a grayish drab color, but a deep, rust-colored patch showed in the fracture in the upper half of the ingot around the depression on top. The alloy was cast a third time, fluxed with soda ash, but remained unchanged in its sand casting qualities. Another trial was then made of the same bronze, but with a smaller amount of silicon, 1½ per cent of silicon-copper being added instead of 4 per cent, as in the first trial, but the castings were still unsatisfactory, as they were of a dull white color and a tendency to develop shrinkage cracks

was noted. As in the preceding case, the alloy was re-melted and re-cast, and this time the castings showed no traces of silicon, which had thus evidently been deoxidized out of the alloy. This result, however, is not always obtained, as traces of the influence of silicon are sometimes visible on the castings for several re-melts.

Copper, Tin and Silicon.

The silicon was then tried with a different alloy, the composition of which was as follows: Copper, 90 per cent, and tin, 10 per cent. A portion of this alloy was re-melted and 3 per cent of silicon-copper was added, and test bars, 1¼ inches square, were cast in sand. The alloy appeared to cast well and the castings looked bright and silvery with a reddish tint. The fracture of the broken bar was not uniform, but showed different colors, being light brown in the center and grayish around the circumference. It was believed that this unfavorable appearance of the fracture might be due to the use of too much silicon in the mixture, and a deoxidizing alloy was accordingly made, containing 30 per cent of silicon-copper and 70 per cent zinc, to form a brittle alloy that could be easily added in any quantity to the metal. This was then used in the place of half of the tin in an alloy containing copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent, the actual proportions taken having been copper, 22 pounds; tin, 1 pound, 4 ounces; silicon-zinc, 1 pound, 4 ounces, and zinc, 8 ounces. A nice appearing sand casting was obtained in the shape of a test bar, 1¼ inches square, but when broken, the fracture was still largely discolored with oxide, although the percentage of silicon in the mixture was as low as 0.15 per cent. This was more than had been used in the copper to make solid castings, but it was considered advisable to begin with 5 per cent of the alloy, and then to reduce the amount in subsequent trials. This was done, and the results showed that when silicon is used as a deoxidizer in bronze, especially when lead is present, 0.03 per cent silicon is as much as should ever be used.

As copper deoxidized with 1 per cent of silicon-copper seemed very tough, a bar was pulled for tensile strength, but only developed 23,000 pounds per square inch and another test made with the addition of zinc and tin gave 26,000 pounds per square inch. The formula used in this latter test was as follows: Copper, 97 per cent; tin, 1.25 per cent; zinc, 1.25 per cent, and silicon-copper, 0.50 per cent.

An alloy of copper, 93.5 per cent; antimony, 5 per cent, and silicon-copper, 1.5 per cent, is hard, sonorous and copper-colored, but is not remarkable for strength, as might be expected from the use of antimony. It is much more rigid than a similar alloy in which the antimony is replaced by tin, but the latter alloy is much stronger and more ductile. The only use that can be suggested for this antimony alloy is for trolley wheels, as it presents the appearance of copper and the flanges are sufficiently rigid to withstand rough use.

An alloy was made containing copper, 80 per cent; lead, 16 per cent, and silicon-copper, 4 per cent, and was cast into sand molds, but the castings were honeycombed on the surface, the holes having been filled with a white powder. Several attempts were made to cast this mixture in sand, but the results were the same in each case and it was impossible to obtain castings free from these defects. The conclusion arrived at, therefore, was that lead should be excluded from castings in which silicon is used, if it is intended to cast the alloy in sand molds.

An alloy of silicon-copper and magnesium was made based on the theory that it might prove superior to silicon-copper alone as a deoxidizer of copper castings, owing to the fact that magnesium possesses greater affinity for oxygen than silicon, and does not lower the conductivity of copper to the same extent. Copper deoxidized with 0.10 per cent magnesium had a conductivity of 87 per cent, while the same quantity of silicon added in the shape of 1 per cent of silicon-copper, lowered the conductivity to below 70. Consequently, as the magnesium was not without its faults, an attempt was made to improve it by the addition of silicon, and an alloy of silicon-copper with 3 per cent of magnesium was made and proved to be a dense, brilliant white alloy, very brittle and externally black in color. At the first trial of this combination of two powerful deoxidizers, the copper was purposely melted without any protective cover of charcoal, and when thoroughly liquid, 0.50 per cent of the silicon-magnesium alloy was added, and the metal was poured into sand molds. As soon as the heads were filled, the metal swelled, and then began to pour out again in a thin stream that overflowed and splashed onto the floor as if being poured from a crucible, and the castings, as would be expected under the circumstances, were very spongy.

Before pouring the next mold, ½ per cent of the silicon-magnesium alloy was again added, and this was continually increased with each mold poured, until 2 per cent had been added without any change in the metal, which continued to rise in the heads and overflow. An examination of the castings showed them to be badly oxidized. At a second trial, the copper was carefully melted under charcoal and 1 per cent of the alloy was added. This time the castings were solid, but in appearance and strength they were inferior to what they would have been, had silicon-copper been used alone. It was evident, therefore, that nothing was to be gained by the use of such a combination of silicon and magnesium in making copper castings. The necessity of charcoal as a cover in melting copper was also emphasized by these tests. Although the castings from the second trial were not of fine appearance, they were at least solid and could be used, while those of the first heat were so rotten they could be broken with a hammer. Charcoal as a covering, therefore, is just as important to success in making copper castings as the use of a deoxidizer, as the latter, however good it may be, will not restore copper that has been ruined in the furnace.

Silicon in Yellow Brass.

Several tests were also made to determine the effects of silicon in yellow brass, and the first alloy tried was ordinary yellow brass with the addition of 4 per cent of silicon-copper. As it had been conclusively shown that lead was detrimental to alloys containing silicon, no lead was used in the yellow metal which was made from new metals. The castings were bright yellow externally and resembled manganese bronze in appearance. They were very tough and ductile, the effect of silicon on yellow brass being very similar to that of aluminum, but the alloy casts better, as it contains less dross. In the following test, the zinc was increased and the silicon-copper decreased. The formula was copper, 62 per cent; zinc, 36.5 per cent, and silicon-copper, 1.5 per cent. The appearance of this alloy was similar to that of the first, but only one test bar was made and pulled, the tensile strength of which was low on account of a flaw. Ordinary yellow metal with 1 per cent of silicon gave a tensile test of 30,300 pounds per square inch, which seemed to indicate that the silicon effected no improvement in its physical qualities, but merely increased the fluidity of the metal. This, however, is not the case, as it was later found that silicon increases the strength of yellow alloys very materially, and the test bars will show the improvement provided they are cast with due precautions to insure soundness. The ductility of yellow brass is considerably enhanced by additions of silicon, and a test bar, 1¼ inches square, was sawed half through and then bent back until doubled, but would not break. The fact that lead cannot be used in these alloys with silicon, limits its field of usefulness, so that it is not probable that it

will ever become a rival of aluminum as a flux for yellow brass, the alloys without lead being too difficult to machine. It occasionally happens, however, that silicon can be used to advantage in place of aluminum as a flux in yellow brass. An instance of this was proved by several splicer ears, which, for the purpose of a test, were cast in aluminized brass and it was found extremely difficult to obtain castings free from dross flakes opposite the gates and shrinkage cracks, where heavy and light portions joined. Although several methods of gating were tried, this trouble could not be overcome, because in order to run the thin parts, the metal had to be strongly poured, and this formed dross. As the alloy contained no lead, silicon was substituted for the aluminum, and the castings were obtained clean and free from all shrinkage defects. The formula used, follows: Copper, 58 per cent; zinc, 40 per cent, and silicon-copper, 2 per cent. The tensile strength of this alloy, as given by a test bar cast in the ordinary manner, was 48,700 pounds per square inch. In tensile strength, this alloy was superior to the red brass ordinarily used in making trolley wire splicers, and it was sufficiently ductile to bend over the wire in a satisfactory manner, but it possesses the disadvantage, common to all high zinc alloys, of being susceptible to slight increases in the zinc content, so that if great care is not exercised in weighing the component parts of the alloy, the castings are liable to be brittle. These alloys are also susceptible to crystallization, and much trouble was experienced with the few splicer ears that were used, as they would break and let down the wire after a few months service, although when put up the castings were sufficiently ductile to permit bending over the wire without any visible cracks. Whether the failure of such metal was due to the passage of electricity, to vibration of the wire, or to defects in the castings when put in use, was never ascertained, as their unsuitability for such a purpose was considered to have been conclusively demonstrated.

Silicon in Manganese Bronze.

The influence of silicon in manganese bronze is similar to aluminum, and the castings appear the same as when aluminum has been used. The metal runs into the molds with the same facility, but it is doubtful whether silicon possesses any advantages over aluminum for this purpose. In the experiments conducted, 1 per cent of silicon-copper was used.

Alloys of copper with iron and silicon can be made, but it makes a considerable difference whether ferro-silicon is used, or whether the iron is first alloyed with the copper and the silicon added later in the form of silicon-copper. In the latter case, the alloys are red in color, and when containing 4 per cent of iron, the metal is as strong, if not stronger, than phosphor bronze. The metal is resilient and has the appearance of copper. These facts were determined by actual tests, an alloy of 97 per cent copper and 3 per cent iron, added as tin plate, being first made, and thoroughly deoxidized. The result was a strong, red, close-grained alloy of silky fracture, and the metal from the ingots could only be broken with difficulty. Sand castings, however, showed slight traces of segregation and to overcome this, 3 per cent of silicon-copper was added. The fracture of the sand cast test bar remained unchanged, and the silicon-copper was then increased to 5 per cent. The castings were strong and ductile and of fine appearance, but with successive meltings the metal became harder and lost much of its ductility. This led to a reduction of the silicon-copper to 4 per cent, and also an increase of the iron to 4 per cent. This change produced an alloy as hard as phosphor bronze, containing 10 per cent tin. The metal was stiff, very ductile and had a dense, uniform, salmon-colored fracture.

Ferro-Silicon Alloys.

When ferro-silicon was used, the resulting alloy resembled a tin bronze in general appearance. An alloy was made of 94 per cent copper and 6 per cent of 50 per cent ferro-silicon. The copper was melted under charcoal and the ferro-silicon was added with a suitable flux, the metal being superheated 10 minutes and a test bar was cast, which gave the following results: Tensile strength, 44,620 pounds per square inch; elastic limit, 24,370 pounds; elongation in 2 inches, 32 per cent; fracture, irregular.

A second alloy was then tried, using 20 per cent ferro-silicon in place of the 50 per cent in the same proportion with copper. The tensile strength of this alloy was 49,960 pounds per square inch; elastic limit, 24,190 pounds; and elongation in 2 inches, 50 per cent. In appearance, the alloy resembled phosphor bronze and was machined without difficulty, the presence of iron being shown neither in the fracture nor on the machined surfaces. The metal was tough at a red heat, and could undoubtedly be forged. When exposed to a gas flame, being alternately heated red and cooled, it turned black, but did not scale. It probably would be found suitable for ignition tubes for gas engines.

To determine the effect of manganese on an alloy of silicon and iron, 2 per cent of manganese-copper was added to the alloy of copper and 50 per cent ferro-silicon, previously described. This resulted in a rigid metal with a mixed fracture, which seemed to be a combination of two alloys—copper and silicon, and copper and manganese. The castings molded in sand were extremely porous and to correct this, 1 per cent of phosphor-copper was added, which resulted in producing still greater porosity. The same result was always obtained when manganese was added to these alloys, but the cause of the porosity was not determined, and it was the only element which produced such effects, as titanium, chromium, tin and nickel, seemed rather to improve the alloy, than otherwise.

Silicon-Copper Alloys.

As the alloys of silicon-copper and iron were cheaper than copper and tin alloys of similar physical characteristics, they were extensively used where a high grade metal was required. They possessed the disadvantage, however, of having to be isolated from all other kinds of brass, as when added to any metal containing lead, the castings were invariably scrapped, and as accidents occasionally happened, due to the difficulty of distinguishing between the gates from the silicon mixtures and other alloys, means were sought to remove the silicon from the mixture. To accomplish this the following alloy was made: Copper, 16 pounds; tin, 1 pound; zinc, 1 pound, and lead, 1 pound. To this alloy, 3 ounces of silicon-copper were added. The resulting sand castings were dirty, of a white color, and could not be used for any purpose. They were remelted and ¼ ounce of magnesium was added. The metal was again run into castings, and an improvement was noted in their external appearance, but the fracture of the alloy was very poor. It was again remelted with another ¼ ounce of magnesium, the object being to discover if this element could be used as an antidote to the silicon in leaded brass mixtures. The alloy originally consisted of 19 pounds of ounce metal, and 3 ounces of silicon-copper, and at the third remelt, ½ ounce of magnesium was also added. The castings from this heat were hard and dirty, of a mottled, greenish drab color, with some black dross on the cope side. The metal was short and broke easily, the fracture showing a core of ordinary poor grade bronze, surrounded by a bluish envelope which exhibited large, tearing crystals. The metal was again re-melted, ¼ ounce of sodium and some oxide of copper having been added. This restored the metal, and the castings were of good color and showed an excellent fracture. It was found more difficult to remove the silicon from the ferro-silicon class of alloys as oxide of copper would not effect its removal alone, but only when lead, magnesium and sodium were also added. This investi-

gation showed that silicon has only a limited application in copper alloys and should never be added to metal containing lead. Its use should be confined chiefly to the production of copper castings and special alloys. The results also proved that ferro-silicon can be alloyed with copper to produce metals stronger than the copper-tin series, and capable of replacing them if tin continues to advance.

Burning Collars on Bronze Valve Stems

By Emil B. Horne

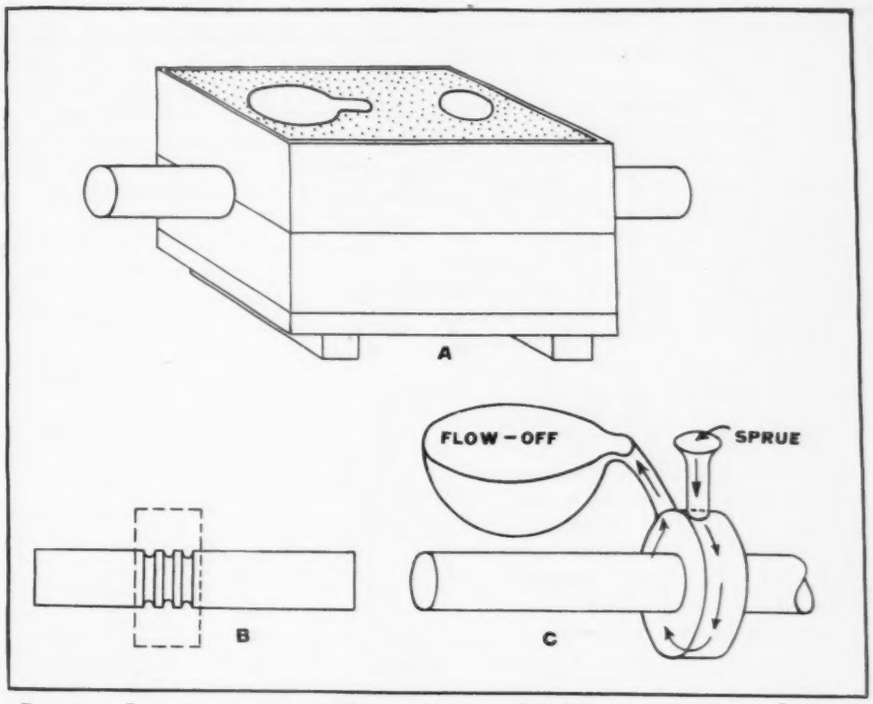
Tobin bronze stems are frequently required on large valves, and whether the latter are of the inside or outside lifting type, a substantial collar is required on the stem in order to lift the plug, and this collar must possess strength sufficient to withstand the pressure of the water or steam against the plug or wedge. A 24-inch valve having a stem 1½ inches in diameter will require a collar of from 2 to 2¼ inches in diameter, and if the specifications demand rolled tobin bronze it is usually necessary to use material 2¼ inches in diameter to provide stock for the collar, and then turn off the other part of the stem to the required dimensions, and to avoid this waste of labor and material, a plan of burning on the collar was devised. A pattern was made in wood of the collar with a hole in the center to admit the stem, and a mold was made of that portion of the stem with the collar on it, in a flask cut away at either end to allow the stem to protrude, as shown at A, in the accompanying illustration, which also shows the position of the sprue and flow-off.

Condition and Amount of Metal.

The metal must be poured hot and should be of the same composition as the stem, and as a rule about five times the weight of the collar will have to be poured into the mold and riser. For stems larger than 2½ inches in diameter it is necessary to cut several grooves where the collar is to be burned-on, to enable the metal to get a better grip on the bar. These large stems also require the sprue to be located directly on the top as at *C*, in the illustration, while with the smaller sizes the sprue is located at the side of the mold. While pouring a steady stream must be maintained, otherwise the metal is likely to become chilled when it strikes the stem, which is not heated but merely freed from dirt and moisture, and as the stem is cold, the mold must be left open until ready to pour to prevent sweating.

Several tests were made in order to obtain some idea of the strength of the weld. A 1-inch bar of tobin bronze had a tensile strength of 45,000 pounds, and a similar rod on which a collar was cast broke at 43,300 pounds, thus showing a loss of only 3.78 per cent of the original strength of the bar.

The test piece broke at one side of the collar, and after the collar was sawed lengthwise, the burned portion proved to have penetrated the metal of the stem to about two-thirds of its extent. An attempt to push off the ring failed, as the machine was not strong enough. It was thus proved that the collars were so firmly attached that the stem was to all intents and purposes solid.



BURNING COLLARS ON BRONZE VALVE STEMS. *A*, SHOWS THE MOLD, *B*, THE METHOD OF GROOVING THE BAR, AND *C*, THE DIRECTION IN WHICH METAL FLOWS

Alloys of Zinc

Alloys of zinc find extensive application for making die-castings, and for many other purposes where a harder metal is required than is possessed by alloys that have a tin base. In addition to zinc, the usual constituents of these alloys are copper, tin, antimony and aluminum. The copper breaks up the crystalline nature of the zinc and the other metals add to the strength and casting qualities. While the copper breaks up the zinc crystals, it does not of itself confer any great strength, and the dual alloy must be supplemented by the addition of either aluminum or tin, or both.

Aluminum is superior to tin in this respect, as the addition of 3 per cent to an alloy of zinc and copper containing 11 per cent of the latter metal, will increase the strength five-fold. Experiments conducted to determine the effects of different metals in building up the strength of alloys of zinc with varying proportions of copper, showed that the addition of antimony was of little value; that manganese made the metal run more sluggish and produced beautiful iridescent colors on the surface of the ingots, but could not be considered an improvement; that sodium in the proportion of 6 per cent had no particular strengthening effect, although it hardened the zinc and produced a fibrous arrangement of the crystals.

When 11 per cent of silicon-copper was used in place of ordinary copper, the strength of the alloy was neither increased nor decreased, the silicon having no effect even when aluminum was so added. This was considered remarkable in view of the great improvement in these alloys produced by aluminum, because silicon affects brass much the same as aluminum, and it was believed it would have a similar influence on alloys of zinc and copper in which the former metal predominated.

This is not the case, however, as

silicon appears to have very little influence on zinc, unless it is alloyed with a considerable amount of copper, as in the case of yellow brass. Phosphorus, especially in conjunction with aluminum, increases the strength of zinc alloys considerably, and an alloy of zinc 88½ pounds, copper 4½ pounds, phosphor copper 4½ pounds and aluminum 2½ pounds, is stronger than cast iron. The effect of tin is to impart a certain amount of ductility to alloys of copper and zinc. The metal lacks the fluidity and stiffness imparted by aluminum, but on the other hand, it can be freely used in brass mixtures, should the occasion arise.

An excellent alloy of copper, zinc and tin is as follows: Zinc, 88 pounds; copper, 6 pounds, and tin 6 pounds. Another good alloy is formed by first making a hardening by melting 4 pounds of copper and adding 4 pounds of zinc, 5 pounds of tin and 5 pounds of lead. This is run into ingots and is added to zinc in the proportion of 6 pounds of the hardening to 20 pounds of zinc.

Brass Foundry Difficulties

SOLVED BY EXPERTS

Gold-Colored Bronze

Please give formulas for the following alloys: Gold-colored bronze, yellow brass that will match tubing, and an aluminum alloy that is suitable for cooking utensils and will withstand repeated heating.

For a golden bronze use the following: Copper, 87 pounds; tin, 6½ pounds; zinc, 3½ pounds, and lead, three pounds. If this alloy proves too expensive, a cheaper, but excellent alloy is formed by a reversal of the proportions of the tin and zinc, given in the foregoing formula. The proportions would then be, zinc, 6½ pounds, and tin, 3½ pounds, and should it be considered advisable to reduce the content of lead for any particular purpose, one pound more of copper should be added for every pound of lead that is omitted. To match yellow brass tubing, the following alloy can be used: Copper, 70 pounds; zinc, 27 pounds; tin, one pound, and lead, two pounds. A satisfactory aluminum alloy follows: Pure aluminum, 94 pounds; copper, six pounds, and magnesium, one-quarter pound.

Casting Yellow Brass

We are making a yellow brass, containing 16 pounds of copper, 7 pounds of zinc, 1 pound of lead and 2 ounces of aluminum. It polishes nicely, but the trade does not like the light color of the castings imparted by the aluminum. We also make a yellow brass, containing 16 pounds of copper, 10 pounds of zinc and 2 ounces of silicon-copper, which also has a nice, bright color, but the trouble is we cannot ream or drill the castings, and when we use lead with this mixture, it will not work with the silicon-copper. Can you advise us how to overcome this difficulty?

The first mixture is an ordinary grade of common yellow brass and there is really no need for the addition of aluminum, beyond the fact that it makes casting easier, by eliminating the smoke, and adds fluidity to the metal. Such mixtures were made and cast many years before aluminum was known in the brass foundry, but it requires more skill to obtain good castings without, than with the aluminum, and that is the reason the latter metal is used so extensively as a flux in yellow brass. The use of aluminum has become so associated with cheap mixtures, which contain too much zinc to be cast without it, and its effect on the appearance of the castings has become so well known that many users of castings have a decided objection to its use, as the natural inference is that a cheap metal is being substituted.

The color of a yellow brass casting without aluminum is red externally, and not yellow. Therefore, it is easy to imagine that it contains more copper, and hence is a better metal than another casting, having the characteristic bright yellow appearance produced by aluminum. There should be no difficulty in obtaining castings without aluminum, provided they are heavy enough to run. All that is necessary is to pour the metal with sufficient force to keep the heads filled so that the smoke cannot get into the castings. This will require some practice. The metal must not be poured too cool, and in this connection it may be well to point out that there are very few castings that should be poured with brass so cool that it does not smoke. Regarding the second alloy, if you desire to add lead, the silicon-copper can be replaced by aluminum, but the casting difficulties will be increased, and the strength of the alloy will be decreased. Therefore, it would be better to reserve this alloy for work requiring a strong, tough metal, and use the first alloy for ordinary castings.

Sluggish Aluminum

We are making cylindrical aluminum castings, 14 inches long, 5 inches in diameter and 1/8 inch thick. The metal is poured at a temperature of 1,300 degrees Fahr. The alloy, which consists of aluminum, 93 per cent, and copper, 7 per cent, is sluggish and does not fill the mold. We would like to know whether we can mix any other metal with the aluminum that will give us better results?

There is a possibility that you are pouring these castings too cool and the metal sets before it can flow around the core. A casting ⅛-inch in thickness and the size you give will require very hot metal to run successfully. A large number of gates will also be required, and if these are arranged down either side of the casting it will be necessary to pierce the highest point of the cope with several vents to allow the metal, as it climbs over the core, to drive out the air. Otherwise, the air will be imprisoned at this point and will be compressed as the metal advances until the pressure of the air equals that of the metal, and when the progress of the latter is stopped, a misrun casting results. The trouble outlined may possibly be overcome by pouring the metal hotter, increasing the number of gates, if this is possible, and by well-venting the cope. The core, also, must be as soft as possible and should be made in halves. Before each half is removed from the core box, scoop out most of the sand in the body so that only a shell remains. Fill the hollow space with molding sand, turn out on the plate and dry. Before the halves are pasted together the molding sand is removed and the finished core is then a mere shell, which the gas can easily penetrate. The metal will flow over such a core much more easily than over

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

FORMULAS FOR THE BRASS FOUNDRYMAN.

Anti-Acid Metals.

While no copper alloy can be said to be acid-proof, there are some alloys that will resist acids much better than others, and because lead is more resistant to acids than most metals, the so-called acid-proof metals are generally highly leaded. An alloy of this type is as follows:

	POUNDS
Copper	72
Phosphor-copper (15 per cent)	3
Tin	1¼
Antimony	3¾
Lead	20

Melt the copper under charcoal, using a flux composed of four ounces of borax, two ounces of soda ash, and eight ounces of sharp sand. When melted, add the phosphor-copper, then the tin and antimony. Stir the metal thoroughly and add the lead. This alloy can be used for all castings that come into contact with acid fluids, but should not be used when great strength is also desirable. Should the castings bleed lead when taken hot from the molds, add two ounces of roll sulphur to the flux.

Strong Alloy.

A stronger alloy for the same purpose, that will also prove satisfactory for bearings, follows:

	POUNDS
Copper	74
Manganese-copper (30 per cent)	1
Tin	5
Lead	20

Melt the copper and afterwards add the other component parts of the alloy in the order given.

Bearing Metal.

Another mixture on the same order, possessing excellent anti-friction qualities combined with low cost, follows:

	POUNDS
Copper	63
Manganese-copper (30 per cent)	5
Antimony	2
Lead	30

Melt the copper, add the manganese-copper, next the antimony and lastly the lead. Stir well, thickly cover with charcoal, drop two pounds of borax onto the charcoal, allow the water to boil out, then stir the contents of the crucible thoroughly.

FORMULAS FOR FURNACE LININGS AND GROUTINGS.

Carborundum Brass Furnace Lining.

Mix together thoroughly the following ingredients:

	PARTS
Carborundum fire sand	80
Dry powdered fire clay	20

Wet to the consistency of molding sand with a mixture of water and silicate of soda, in the proportions of half and half. This mixture is used to form furnace linings by being rammed when moist between the furnace shell and a sheet iron or wooden form which determines the size of the furnace, and is afterwards removed.

Producer Groutings.

An elastic filling to be used between the fire brick lining and the shell of producers is made by mixing thoroughly in a dry condition—

	PARTS
Silica sand	40
Dry fire clay	40

Add to this mixture 20 parts of coal tar and thoroughly incorporate, using heat if necessary. The mass should not be sticky and is tamped in place like sand.

Furnace Cement.

	PARTS
Dry pulverized fire clay	4½
Oxide of manganese	1½
Borax	½
Salt	½

Mix with water to a paste, apply to the cracks and heat gradually.

Ladle Daubing.

A daubing for small ladles that has met with considerable success is made as follows:

	PARTS
Loam sand	75
Sharp or silica sand	15
Dry core compound	10

Mix, and dry thoroughly after application to the ladles.

THE FOUNDRY DATA SHEET, AUGUST, 1911

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

a solid core equipped with the usual small vent. Be certain that the ingot aluminum is pure aluminum and not remelted metal, and if you desire to try other alloys, the following can be recommended: (1) Aluminum, 94 per cent; copper, 6 per cent. (2) Aluminum, 95 per cent; copper, 5 per cent. (3) Aluminum, 81 per cent; copper, 2 per cent; zinc 15 per cent; tin, 2 per cent. (4) Aluminum, 98 per cent; magnesium, 2 per cent.

Ductile Aluminum

We would like a formula for a strong, tough alloy of aluminum, suitable for casting dough beaters, used in bread-making machines. Kindly inform us if clean copper clippings will melt in aluminum without having to heat the latter to a temperature sufficiently high to injure it. Will the addition of tin make an aluminum mixture stronger or tougher, and if not, what would you advise us to use for this purpose?

If a very strong and tough alloy is necessary for the purpose you mention, we doubt whether any casting alloy of aluminum will be found suitable, as such metals do not possess the strength, combined with the ductility, of the alloys of copper. Copper in alloy with tin, zinc and various other metals, is capable of producing a metal much stronger and tougher than copper alone, but aluminum differs in this respect, as the original ductility of the metal, instead of being increased, is generally diminished by the addition of other metals. Therefore, when an alloy possessing sufficient ductility to bend without breaking is essential, only a slight admixture of other metals can be made to the aluminum, otherwise it will more nearly approach the physical characteristics of cast iron, and while stronger than when pure, will bend but slightly, and can be broken quite easily by impact.

The following alloy can be recommended: Aluminum, 95 pounds; copper, 4 pounds, and phosphor-copper (15 per cent), 1 pound. The copper can be added to advantage in the form of clean clippings and only a portion of the aluminum need be heated to the temperature necessary to make the alloy, which is a bright red. The clippings are added gradually so as not to chill the aluminum, and when dissolved, the mixture is stirred and the remainder of the aluminum is added. The phosphor-copper can be powdered and added with the clippings. No special advantage will be gained by the use of tin, as it hardens aluminum and decreases its ductility. An alloy containing tin follows: Aluminum, 84 pounds; zinc, 12 pounds; copper, 2 pounds, and tin, 2 pounds.

Pattern Alloys

In making brass patterns for gated work, we experience trouble from hard castings. The formula we use is as follows: Copper, 20 pounds; zinc, 1½ pounds; tin, 1¼ pounds, and lead, ¾ pound. The metal is melted with coke in pit furnaces, and the molds are made of fine sand. Will you kindly give us a formula for this kind of work, together with instructions for melting?

By a reversal of the proportions of the tin and lead in this alloy, a metal will be obtained that can be worked more easily and may possibly meet your requirements. The alloy will then be as follows: Copper, 20 pounds; zinc, 1½ pounds; tin, ¾ pound, and lead, 1¼ pounds. A very free cutting alloy can be made as follows: Copper, 20 pounds; lead, 2 pounds, and zinc, 2 pounds. We advise that you try this metal and if found too soft, tin may be added. The molding practice is correct and should produce satisfactory castings, therefore, no change in this respect is advisable. In regard to the melting conditions, use new metal as much as possible for making the brass, as one thing to be guarded against is the presence of iron in the metal. Therefore, if scrap copper is used, care should be exercised to exclude iron from the mixture. This precludes the use of fine scrap copper wire, as, occasionally, thin, copper-coated iron wire will become entangled in the cabbaged mass to the detriment of the resulting castings.

Calcium and Molybdenum in Copper Alloys

A formula for improving the conductivity and tensile strength of copper and its alloys has recently been patented by Rudolph Franke, of Eiseleben, Germany. Both bronze and copper wire are used in Germany, and to deoxidize and otherwise improve the metal, before it is drawn into wire, it has been the practice to treat it with an alloy consisting of 64 parts of aluminum and 36 parts of magnesium. This has not proved entirely satisfactory and experiments were made to ascertain whether this alloy could not be advantageously replaced by either calcium or molybdenum. The results of the tests proved the superiority of calcium added in the form of calcium-copper, and it was found that molybdenum was similar in its effects to calcium. The tests also proved that combinations of calcium and molybdenum produced good results, but that neither calcium nor molybdenum should be used in combination with aluminum. About 0.35 per cent of calcium or molybdenum alone or in combination is recommended, and it is claimed that it greatly increases the tensile strength of the wire treated therewith, which then possesses a conductivity of 95 per cent. The calcium-copper that was used contained 12.2 per cent calcium and the molybdenum was added in the form of a metallic powder containing 97.1 per cent molybdenum.

Chandelier Work

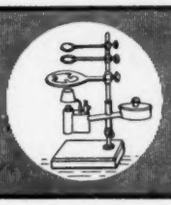
We have recently received orders for light brass work, consisting of scrolls, leaves and other thin castings, such as are used on chandeliers and electroliers. We are casting them in dipping brass, and experience much trouble from misrun, rough and dirty castings. Our usual line of work consists of machinery castings and miscellaneous jobbing work, comparatively heavy in character, but we desire also to handle thin, light work.

Chandelier work is cast both horizontally and vertically, and to successfully run the castings it is necessary to master the art of pouring and to use numerous gates. In casting horizontal molds it is customary to raise the sprue end of the mold several inches, to rest the lip of the pot on the flask and to give one quick decisive dip, which throws just the right amount of metal into the mold to run the castings, but not to entirely fill the sprue. Any hesitancy in pouring, whether the molds are vertical or horizontal, will produce misrun castings; consequently, every effort should be made to master this part of the process. The addition of a few ounces of aluminum to the alloy will greatly simplify the pouring, as the fluidity of the metal is increased and the smoke diminished. The surface of the metal can be seen, and if the metal is poured in a good steady stream, the castings will run without the necessity of dashing it into the mold. The castings, however, are not as fine in appearance when dipped as when made without the use of aluminum, and for this reason there is some prejudice against its use. When the brass is not leaded, the use of 1½ per cent of silicon-copper produces the same fluid effect as aluminum, but does not cause drossing to the same extent. Rough and dirty castings are caused by coarse sand and it will be necessary to either use a facing of fine sand next to the patterns, or to devote one or more sand piles to this class of work. Do not crowd too many patterns into a mold, as half of its area will be occupied with the gates and it will not pay to economize in their use. In gating a

rosette, for instance, it will often be found necessary to place it in the center of a ring, formed of 5/16-inch round iron, and about 1½ inches larger in diameter than the rosette. This ring is connected to the runner and forms the gate for the rosette, which is connected to the ring by small branches cut in the cope and which conduct the metal from the ring gate to the back of the rosette, the little lumps left by the gate being afterward ground off. It will probably be necessary to skin dry the molds and, therefore, they should be lightly sprayed with molasses water before they are finished. Just before pouring, they are torched, or surface dried in any other suitable manner.

Easy Lessons in Chemistry

By CHARLES VICKERS



TO MEET the insistent demands of modern engineering for high physical qualities in non-ferrous alloys, constant efforts are being put forth to effect their improvement, and as a consequence many elementary substances formerly little known have become commercially available. One of the most recent of these contributions to the metallurgy of the brass foundry is boron, which has been recommended as a deoxidizer of copper, and considerable interest centers around this element because it is claimed that it does not form an alloy with copper, but merely combines with the oxygen, which is thus slagged out of the metal, leaving the latter in its original state of purity. If the excess oxygen is removed, and the copper is melted with sufficient care to prevent undue absorption of other gases, castings of pure copper that are perfectly solid can be made, and the conductivity of such castings will be high because they are pure, as it is the foreign elements that must be added to copper to promote solidity in the castings, that lower its conductivity. Heretofore castings of pure copper have not been commercially available, for although claims have been put forth from time to time of the discovery of such a method, upon investigation it is usually found that some deoxidizing element was required, and that as a consequence the electric conductivity of the copper is lower than that of the pure metal.

Elimination of Oxygen.

The only manner in which oxygen can be eliminated from copper other than by the introduction of some foreign substance, is by the process known as poling, practiced in the final stage of the refining of copper. In the founding of copper poling is seldom practiced, especially when the metal is melted in crucibles, as the introduction of a stick of green wood into a crucible nearly full of molten copper causes considerable commotion, which spatters the metal, some of which escapes the pot and is lost. The addition of some metal or metalloid that will remove the oxygen from the copper is the most feasible method of elimination in the foundry, and for this purpose phosphorus, silicon, manganese, etc., are all used, and in the case of alloys are open to slight objection, as the conductivity of brass or bronze is rarely of great importance. In the case of copper castings when conductivity is an object, poling is sometimes practiced, but even then the addition of silicon is advisable, although less can, of course, be used than if poling is not done, as much of the oxygen is eliminated thereby. The addition of silicon, however, lowers the conductivity of the castings as it is not possible to so gage the amount added, that it will be just sufficient to remove the oxygen and not leave any excess to alloy with the copper, consequently some little margin of safety must be allowed, and an alloy of copper with silicon is formed the conductivity of which falls below that of the pure metal. If boron, therefore, as is claimed, will unite with the oxygen and not with the copper, it would not greatly matter if an excess was used, as it would simply rise to the surface of the metal with the rest of the slag.

Boron in character is similar to carbon, that is it belongs to the same natural family, with a leaning in some of its forms towards the metals. It is found in nature in combination with oxygen as boracic acid, and also in other forms, the most familiar of which is borax, a combination of boron, oxygen, sodium, and when in the crystalline state, water. Borax has a slightly alkaline taste and reaction, and when heated bubbles up, loses its water and just below a red heat melts into a transparent glass. The value of borax in brazing is well known, and is due to its power of dissolving metallic oxides which form a film on the surfaces to be brazed, and prevent the union of the solder or spelter. Borax is largely obtained by dissolving native boracic acid in a hot solution of carbonate of sodium. It is of value in melting operations as well as for brazing, especially in making alloys high in lead.

Boracic acid is the only oxide of boron known, its composition is three atoms of oxygen and two of boron, and like borax it contains water and when heated becomes fluid or melts in its water of crystallization, then if the heat is continued the mass becomes pasty and swells up, as the water is expelled and when all the water has been driven out by a strong heat, a clear viscous liquid is left which solidifies when cool to a glass, which afterwards cracks and splits up.

Boric Anhydride.

The substance is anhydrous boracic acid, or boric anhydride, the reduction of which by means of magnesium or sodium, produces amorphous boron, which resembles the charcoal modification of carbon, other forms of boron being the crystalline and the graphitic, the first named resembling the diamond in hardness and other qualities, and the latter is similar to graphite, but of a reddish color. The amorphous condition of boron is best for making additions to copper, as figuring from the analogous case of carbon neither the graphitic or the crystalline condition would be of value for such a purpose.

The amorphous boron can be prepared from boric anhydride by reduction with sodium or magnesium, in the former case 100 parts of anhydride are mixed with 50 parts of sodium in small lumps, and the mixture is then thrown into a strongly heated crucible, preferably iron, and the air is excluded by a flux of salt. The reaction proceeds rapidly and is assisted by stirring with an iron rod, after which the fused mass can be poured into water, or left until cool and then washed in acidulated water, which dissolves the borax and salt, while the boron settles to the bottom as an insoluble powder, which

is then washed, and carefully dried. Amorphous boron is a greenish powder which readily takes fire when dry and a ray of sunshine falling upon it is frequently sufficient to cause it to enflame. A high state of purity, however, is not necessary for metallurgical purposes, so that it can be mixed with anhydride, and when magnesium is used in its reduction, some of the latter will remain as magnesium borate, thus a mixture results of amorphous boron, boric anhydride and magnesium borate. It is the amorphous boron, however, that removes the oxygen from the molten copper, and produces solid castings.

Boron Bronze.

As to the truth of the statement that boron does not form an alloy with copper some doubt may be permitted, as boron has been used for some time in alloy with copper and aluminum, to form boron bronze. This alloy is also known under other names, and the addition of boron is claimed to effect great improvements in aluminum bronze, making it more dense and strong, but its greatest effect is the influence it exerts on the casting qualities of aluminum bronze, as it is claimed that by its use perfect castings are easily obtained. The effect of boron on the density and strength of aluminum bronze can be easily understood, whether it enters into admixture with the metal or not, as its power to deoxide would account for that, but the improvement in casting qualities would indicate that it entered into the alloy, and by its presence was able to either counteract the formation of aluminum oxide, or to reduce the same when formed. It would be strange if it would do this, as aluminum is able to reduce boron from its oxide, it seems, therefore, that the reverse could hardly occur, and that, therefore, the reputed influence of boron on the casting qualities of aluminum bronze is largely imaginary. This leaves the question open as to whether boron combines with copper or not, and is an interesting field for investigation.

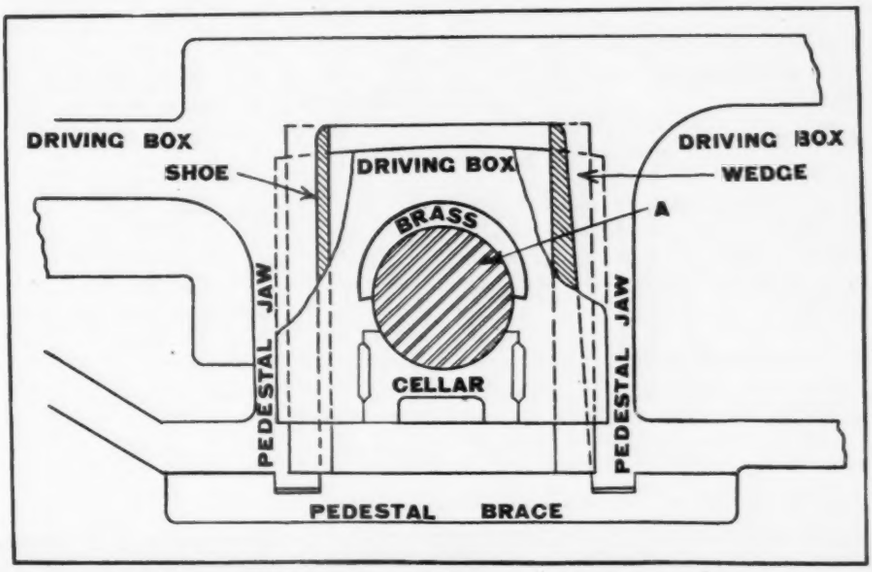
Amorphous boron, like charcoal, dissolves in certain metals, thus when charcoal is heated together with wrought iron it penetrates the latter, and converts it into steel. In a similar manner, boron enters into combination with aluminum, and converts it into a crystalline and brittle substance, this is taken advantage of in forming boron bronze. A mixture of boric anhydride and fluor-spar is heated at a high temperature until dense fumes of boron fluoride appear, ingots of aluminum are then introduced into the molten mass, reduction of boron takes place and an alloy of aluminum and boron is formed, that is used in the production of the bronze, the percentage used to form the alloy being anywhere from 1 to 8 per cent.

Replacing Worn Brass Surfaces by Burning-On

By Louis Luhrsen

Locomotive driving boxes and wedges are generally made of cast iron, but on account of the superior strength and wearing qualities of brass, this material is now being largely used. These shoes and wedges are placed between the driving box flanges and the face of the pedestal jaw, and are supported on the bottom by the pedestal brace. An engine having eight drives requires eight wedges and eight shoes, the weight of each being 100 pounds. All surfaces of the castings are machined to insure a perfect fit, and when worn off ⅜ inch, they must be replaced, the scrap castings being returned to the foundry. As the scrap castings, with the exception of the worn face, are as good as new, a plan was devised to prolong their usefulness by burning-on new faces. This plan proved successful and none has yet failed in service. After polishing the surface to be burned, two grooves are planed in the face, ⅜ inch deep, to cast the new metal. A pattern is made corresponding with the face of the casting in length and width, the thickness being governed by the amount of brass to be burned-on. The pattern is placed on a follow board with the brass wedge on top, and at the end of the mold, opposite the gate, a heavy bushing pattern is placed to serve as a riser or flow-off. This bushing requires 20 pounds of metal and is used for the side rod of a locomotive, and a riser is taken off in the cope from the bushing on the side farthest from the wedge.

The pouring gate on the other end of the wedge is cut the full width of the wedge and deep enough to take the metal rapidly. The accompanying illustration shows the driving box, and gives the relative positions of the wedge and shoe, and clearly illustrates the manner in which they are supported by the pedestal brace. A section of the wheel axle is shown at *A*. No loose sand should be left around the gate, the metal must be very hot and the pouring requires good judgment. As the metal used in the wedge is the same as required for the bushing used as an overflow, the latter can be used as an independent casting. Thus, it will be noted, that the waste of metal is limited to the gates and riser by using a stock pattern as an overflow. The composition of the metal follows: Copper, 100 pounds; tin, 10 pounds; lead, 10 pounds, and heavy scrap brass, 180 pounds.



LOCOMOTIVE DRIVING WHEEL BEARING, SHOWING THE POSITION OF THE WEDGE AND SHOE

The Davis-Bournonville Acetylene Development Co. and the National Pneumatic Co. have appointed the Davis-Bournonville Co., New York City, their exclusive selling agent for welding and cutting apparatus. The business of the Davis - Bournonville Co. will be divided into the eastern department with offices at 90 West street, New York City, and the western department with offices at 515 Laftin street, Chicago.

MACHINE-MOLDED PUMP CASTINGS

Novel equipment for the rapid handling of molds made on jar-ramming machines including gratings over which molds are shaken-out

THE Laidlaw-Dunn-Gordon Co., Elmwood place, Cincinnati, has added a machine casting department to its foundry, in which all the work is handled on stripping plate and jar-ramming molding machines. The old foundry is 120 feet wide and 198 feet long, while the new addition adds 162 feet to the length, being of the same width and height. This extension consists of nine bays, each 18 feet wide, divided longitudinally into one high center aisle, 55 feet wide, and two side aisles, each approximately 27 feet wide. Steel frame construction with steel roof trusses and brick curtain walls is used throughout. Light for the main bay is admitted through the monitor windows at the sides and the continuous roof skylight. Both side aisles are lighted by a continuous row of windows on either side.

The crane runway of the new foundry is continuous with the main foundry craneway. In addition to the two 20-ton cranes serving the main foundry, two 10-ton cranes have been installed, making a total of four cranes in the center aisle of the machine and main foundries. One 20-ton and one 10-ton crane are used in the machine foundry and the other 20-ton and 10-ton cranes in the main foundry. The crane runway over the flask yard of the old foundry has been extended to serve the yard of the machine foundry and is commanded by a 10-ton crane, having a 60-foot span. A two-ton Sprague crane and air hoist serve one aisle of the machine foundry.

One 72-inch Whiting cupola, installed adjacent to the old cupola, furnishes the metal to the extension. The cupolas and foundry office are in the center of one of the side aisles, the office being built directly over the blower room. A half hexagonal bay on the side of the office affords an unlimited view of both ends of the main bay. Small cores are baked in a battery of eight Millett core ovens, and a 17 x 20-foot oven has been installed for drying molds and large cores. All small cores, including cylinder cores, 26 inches long and 9 inches in diameter, are made by girls. Separate retiring and lunch rooms are provided for the female operatives. The cores are delivered to the molders in the foundry through a slide door by the forewoman in charge of the core room.

In the east end of the machine foundry, ten stripping plate molding machines, installed by Henry E. Pridmore, Chicago, are used for handling a miscellaneous line of medium and light work. In the opposite end of the main bay of this shop are installed two jolt-ramming molding machines, built by the Mumford Molding Machine Co., New York. The 16-inch machine has a table, 6 feet square, and is of 9,000 pounds capacity, and the 32-inch machine is provided with a table, 6 x 9 feet, and has a capacity of 40,000 pounds. On these jolt-ramming machines is handled a large variety of heavy miscellaneous castings, covering everything from a small housing to engine beds and steam pump bodies. The foundations for these jolt machines are set in a pit, 45 feet square and approximately 12 feet deep. This pit has a cement floor and is covered partly by two steel gratings, the covering of this pit being practically on a level with the foundry floor and a continuous part of the same. The machines are mounted so as to place their tables flush with the covering of the pit or on a level with the foundry floor. As shown in Fig. 2, the gratings are spaced some distance apart, one opposite each jolt machine, which are located directly in front of the foundry office. These gratings are built of $\frac{7}{16}$-inch bars, 3 inches deep, with spaces 2 inches wide and are laid in three 4-foot sections in parallel positions across the floor of the pit covering.

It is the ultimate intention, after the molds have been rammed on the jolt machines, to carry the flasks to one end of the floor, where the cores will be set and the molds poured. Instead of shaking-out the castings, however, where they are poured, they will be returned and shaken-out over the gratings, the sand falling into the pit underneath the floor. The flasks will then be piled on the solid section of the pit covering ready for use the next day. Two sets

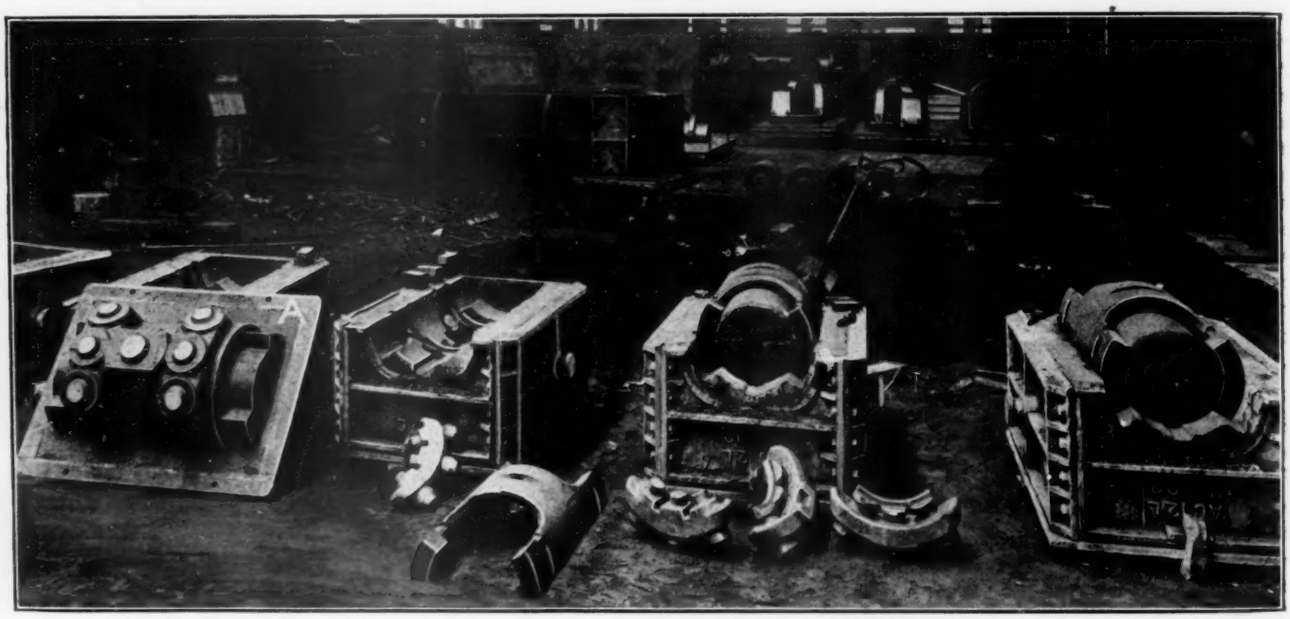


FIG. 1—MOLDS FOR 12-INCH AIR CYLINDERS, MADE ON STRIPPING PLATE MACHINES

of gratings are provided, one on either side of the pit, and on alternate nights the flasks will be shaken-out over each of these respective gratings, thus affording a day for cooling the sand in the pit before it is used again. In the pit the sand will be screened and tempered and will be delivered to the flasks on the molding machines by an elevator discharging into spouts over each machine.

The Laidlaw-Dunn-Gordon Co. has mounted practically all of its large patterns for use on the jolt-ramming machines. These include all sizes of engine beds, air compressor beds, pump bodies, and steam and air cylinders. A few of these patterns and the method of mounting them for use on jolt machines are shown in the accompanying illustrations. A uniform type of bottom board is used for all large patterns. In Fig. 1 are shown right and left hand engine bed patterns, mounted for making molds on the jarring machines. The bottom boards on these patterns are similar to those used on all of the large patterns in this shop. The bottom boards consist of three 4 x 9-inch, white pine battens, extending lengthwise of the patterns, with 2 x 4-inch battens across their ends. On these battens are two thicknesses of white pine, 1¼-inch plank. The first thickness of pine is placed at right angle to the battens and the upper layer at right angle to the lower layer or parallel to the battens and lengthwise of the pattern. Around the outside of the lower thickness of the bottom boards a strip of ¼-inch steel, 2 inches wide, is attached to protect the bottom board. There are two 2-inch vibrator sockets to receive the mechanical vibrators that are used when drawing the pattern. Four hooks are bolted to the back of the pattern between the battens to take the crane chain hooks for conveying the pattern through the shop. The engine bed patterns are hollow and are built-up separately before being attached to the bottom boards. Two vertical, full-length planks are used in the center to strengthen the pattern and to provide a base.

In Fig. 5, *B* and *C* are the two halves of a large pump body pattern. The drag and cope parts of this pattern can be detached from the bottom board, *A*, and are both molded by using the same bottom board, which is attached to the patterns with dowel pins and screws; *D* is flask, both cope and drag halves. Iron, ribbed flasks, made adjustable and in sections, are used throughout for jarring machine work. The bottom board for this pump body pattern has four 4 x 9-inch battens instead of three, as on the engine bed bottom boards, but otherwise the construction is the same. One of the two

FIG. 2—JOLT-RAMMING MOLDING FLOOR, SHOWING THE TWO GRATINGS, ON WHICH LARGE CASTINGS ARE SHAKEN-OUT

floor gratings is shown in the foreground. At *F* is a small housing pattern, mounted for use on the jarring machines. The bottom board, to which this pattern is attached, is 24 inches wide and 36 inches long, and the four battens, 3 inches thick and 4 inches wide, are placed crosswise of the boards. The double thickness of boards and 2-inch sheet metal lining are similar to these on the other bottom boards.

In Fig. 3 is shown an air vessel and discharge cap pattern for a 16-inch pump body. Both drag and cope are made from the same pattern. The inside diameter of this vessel is 38 inches. The bottom board is built on three battens and is 7 feet wide and 10 feet long. An iron, ribbed flask, 8 feet 6 inches long, 7 feet wide and 34 inches deep, is used for both drag and cope. In the foreground, at *A*, is the 6 x 9-foot table of the 20-ton jolt machine. At *B* is the controlling valve for operating this machine. By adjusting the release valve, sufficient back pressure can be obtained to eliminate the shock.

For rapping the patterns, Mumford mechanical air vibrators are used. For drawing these patterns clear of the molds, four screws are used, one at each of the four corners of the flask. These screws are 1⅛ inches in diameter and 24 inches long and are turned by a 14-inch hand wheel. The screws en-

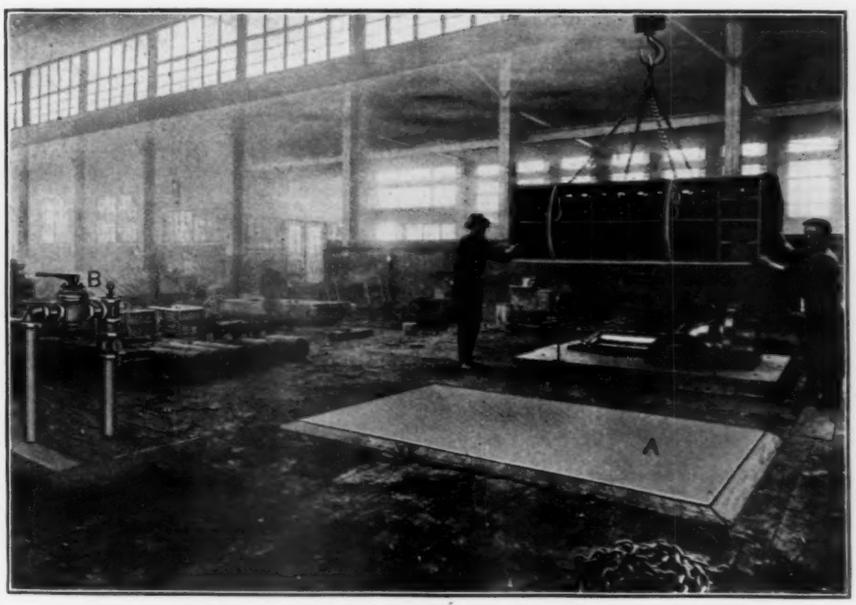


FIG. 3—THE TABLE OF A 20-TON JAR-RAMMING MOLDING MACHINE IS SHOWN AT *A*, AND IN THE BACKGROUND IS SHOWN A PATTERN, OVER WHICH A FLASK IS BEING LOWERED

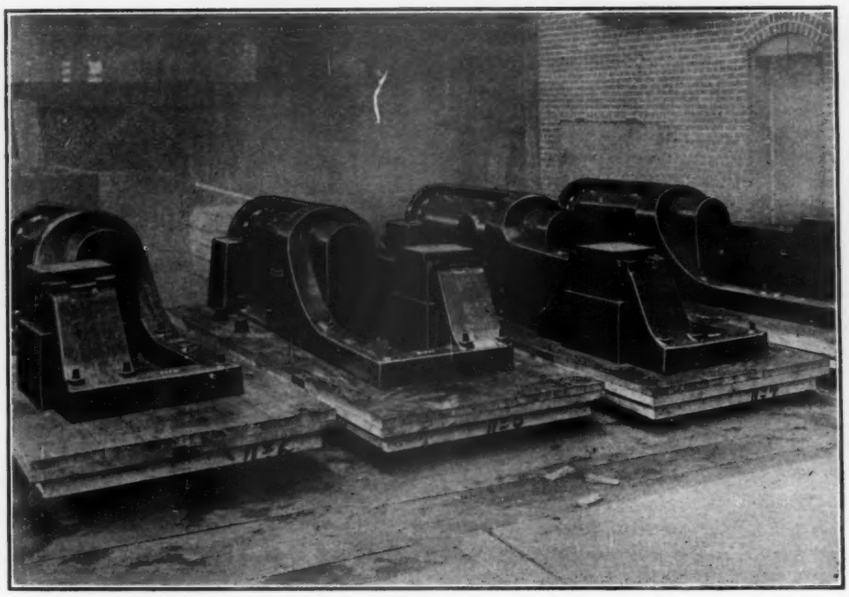


FIG. 4—PATTERNS FOR ENGINE BEDS, SHOWING THE METHOD OF MOUNTING THEM ON BOARDS FOR MOLDING ON THE JAR-RAMMING MACHINES

gage with screw plates set in the bottom boards and their ends are forced against the top web of the flask, forcing the pattern out.

The use of the jolt-ramming machines has reduced the time for molding large castings in this shop, approximately 50 per cent. Making molds on these machines is a very simple operation, consisting merely of placing the flask on the board, filling with sand, jolting, striking-off, rolling-over and drawing the pattern. Drag and cope are made and treated practically alike, except that in some cases they differ somewhat in size. When the mechanical sand conveyor and elevators have been installed, the time of molding this class of work will be greatly reduced, as the filling of the flask with sand at present represents a considerable part of the total time consumed in making the mold.

Fig. 1 shows cope and drag flasks, pattern and cores for 12-inch, straight-line air cylinders, made on stripping plate machines. A metal pattern as shown at *A*, is used for molding these cylinders. Special iron flasks with iron trunnions for rolling over by the crane are used for molding these cylinders. In Fig. 6 are shown some of the large castings, made on the jolt-ramming machines in this foundry.

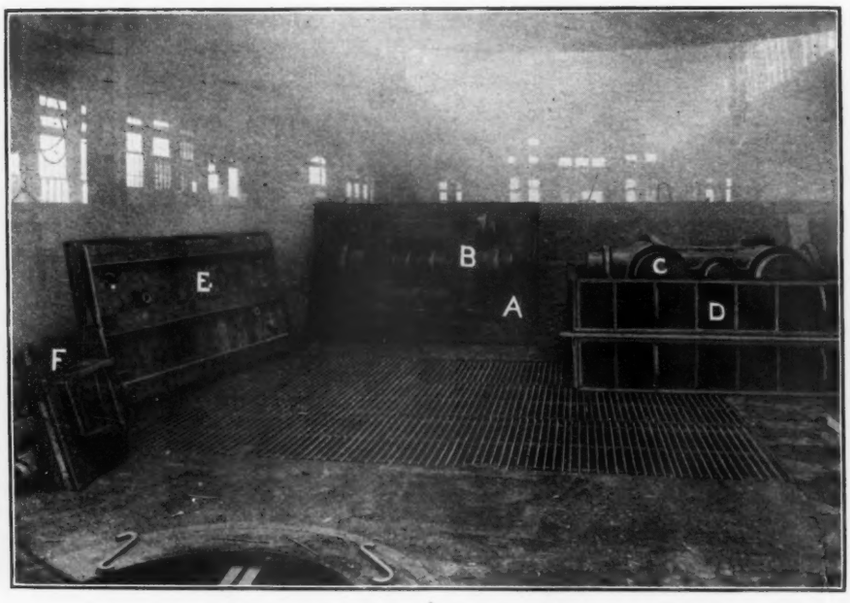


FIG. 5—PUMP BODY PATTERNS, FLASK AND BOTTOM BOARD

Instructions in Foundry Chemistry*

By Herbert E. Field.

CAST iron must contain carbon or it would not be cast iron. Silicon is essential to regulate the form of the carbon in all the various grades of cast iron. Phosphorus is a necessity only in the lighter grades of cast iron, when fluidity and exactness of outline are necessary. Phosphorus increases or prolongs the fluidity of molten cast iron; it makes cast iron weak and short; it may either decrease or increase shrinkage and hardness.

Low phosphorus pig iron frequently analyzes as low as 0.015 per cent in phosphorus, but the ordinary grades of foundry pig iron run from 0.2 to 1.50 per cent in phosphorus. Castings could, therefore, be made of almost any phosphorus content desired up to 1.50 per cent, but, as will be noted later, its harmful effects necessitate its being kept as low as possible, and still have the molten iron possess the requisite amount of fluidity and the casting take sufficient exactness of outline.

Condition of Phosphorus in Cast Iron.

The condition of the phosphorus in cast iron has not been sufficiently investigated to warrant definite conclusions. It probably occurs in at least three conditions in solid cast iron, as phosphide of iron, as phosphide of manganese, and as a part of the iron eutectic. In molten iron it apparently exists in a form similar to a dissolved gas.

We have noted that the condition of the carbon determines the quality of cast iron. Phosphorus has a marked effect on the condition of the carbon. By prolonging the fluidity of the iron, or rather the time it takes for the iron to set, phosphorus gives more time for the carbon to separate out as graphitic carbon. This action then tends to decrease combined carbon and increase free carbon.

Phosphorus reduces the ability of iron to hold carbon in solution so that most high phosphorus irons are low in total carbon. This is not only true of high phosphorus pig irons but of high phosphorus cast iron. Irons high in phosphorus lose more, or rather absorb less, carbon in melting in a cupola than low phosphorus irons.

The direct effect of phosphorus on

*Presented at the Pittsburg convention of the American Foundrymen's Association.

iron is to cause it to assume large crystals due to the fact that the phosphorus prolongs the cooling of the iron just as the iron is solidifying. This phenomena is disguised to a certain extent by the action of the phosphorus prolonging the separation of carbon, but experience with steel with its small percentage of carbon has proven that this phosphorus has a direct effect on the structure of the iron itself.

When cast iron cools, the iron itself may crystallize out and leave what is known as the eutectic to solidify last. When phosphorus is present in excess it forms a part of this eutectic, which surrounds the crystals of iron previously solidified. This eutectic solidifies later and in cooling causes strains in the iron which tend to make it brittle.

Phosphorus as a Promoter of Fluidity.

The principal beneficial effect of phosphorus is to increase fluidity, or rather to prolong fluidity. The temperature of the molten iron is not increased by the presence of phosphorus, but the interval consumed by iron in solidifying is much prolonged by the presence of phosphorus.

This property makes high phosphorus iron valuable in thin sections, as it fills the smallest crevices of the mold. Phosphorus is of inestimable value in ornamental castings when a clearness of outline is the all-important factor. By prolonging fluidity, phosphorus gives time for all dirt and dross to rise to the top of the metal. Phosphorus is, therefore, a necessity to many foundries and would be a great help to all if it were not for the fact that it makes iron brittle and cold short.

Phosphorus and Its Effect on Strength.

Phosphorus makes cast iron cold short and brittle, and liable to break under light shock. Castings, which are subject to rough usage and which are liable to undergo shocks and strains must, therefore, not contain a high percentage of prosphorus. This is true, also, of castings which must undergo strains in cooling, caused by unequal sections. If a casting has a large and small section adjacent, the light section will set and contract first, when the large section cools it will contract, and. if the phosphorus is high, it may crack the small section.

The direct action of phosphorus on cast iron is to harden; its indirect action is to soften. Phosphorus prolongs the cooling of the iron, and hence its indirect action is to soften the iron. If there were no carbon, phosphorus would harden iron.

Phosphorus segregates in the heavier parts of castings, and there is generally more phosphorus in the parts of a casting which set last. This segregation of phosphorus in the larger section tends to keep those sections liquid for a longer time. This gives more opportunity for those parts of the casting, which have already solidified, to draw away from these portions and cause a shrink. On the other hand, phosphorus in prolonging the cooling gives more time for the separation of graphite, and hence tends to decrease shrinkage. The character of the castings determines which effect will predominate. In castings which consist of heavy and light sections adjacent to each other, phosphorus may be said to increase shrinkage. In light castings of uniform section, phosphorus may decrease shrinkage.

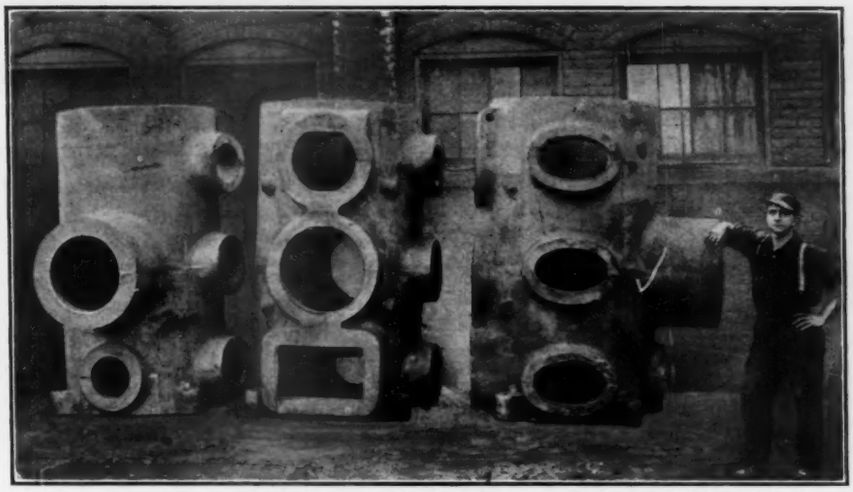


FIG. 6—SOME OF THE LARGE CASTINGS MOLDED ON THE JAR-RAMMING MACHINES

Definitions.

Eutectic. — The eutectic as applied to cast iron is that portion of the cast iron which solidifies last in cooling. When cast iron cools, a portion of the iron. carbon, etc., crystallizes or solidifies out until the remaining molten mass reaches a certain composition. When this composition is reached, the whole of the remaining mass solidifies at once. This portion which solidifies last is known as the eutectic.

Segregation. — Segregation, as applied to cast iron, refers to the separation of the different elements from the whole mass in cooling and their collecting together in one place. For example, phosphorus in large sections collects together in the point which solidifies last, generally the center. This collecting together is called segregation.

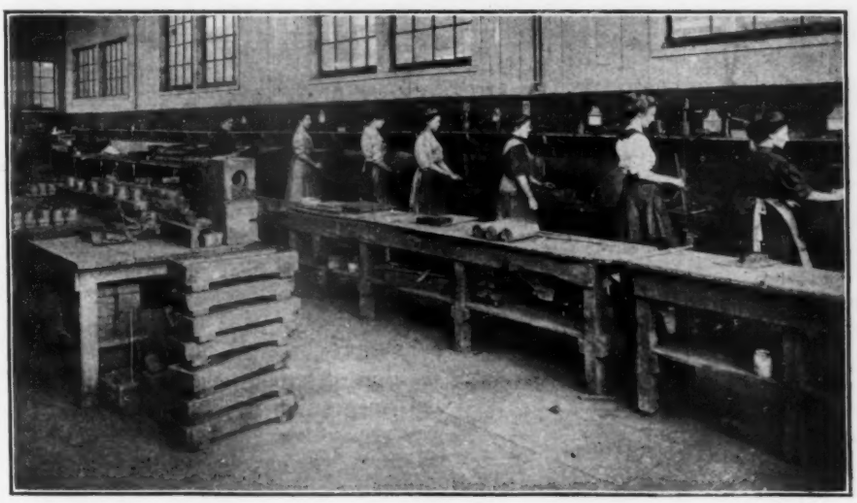


FIG. 7—A SECTION OF THE CORE ROOM, IN WHICH GIRLS ARE EMPLOYED

DEFECTIVE CASTINGS--How to Handle Them*

How losses can be reduced by the adoption of the bonus and piecework system -- Trouble men

By John M. Perkins.

"DEFECTIVE castings, and how to handle them," is a broad subject and one on which the success of the foundry industry very largely depends. It is of vital importance to the foundry owner, to his manager, to his foreman and to his molders and coremakers. In fact there is scarcely an employe in the foundry who does not feel the baneful effect of defective castings. This, to my mind, is as it should be, and if it spurs each and every one in the foundry to an earnest endeavor to find out the causes and remedies for the bad work, the result will be a substantial decrease in the amount of defective castings.

Let us consider the subject from two viewpoints. First, how to reduce the percentage of defective castings; second, having made castings which are not perfect, where shall the line be drawn between those which, for all practical purposes are good, and those which must go to the scrap pile?

Reducing Percentage of Defective Castings.

Taking up the subject from our first viewpoint, let us endeavor to follow a casting from its inception until it is ready for the machine shop. A casting really starts in the draughting room of the designing engineer's office. Right here is where a great many defective castings are made. Every engineer cannot be expected to have a foundry experience, however valuable or necessary to successful work that may be, but he can be expected to keep in touch with the foundry and those interested in its work; in this way, many points vital to the successful making of a casting may be put into a design without injuring the final efficiency of the machine of which this casting may be a part. There are many minor details, seemingly of no importance to the engineer, but of vital interest to the foundryman in his attempt to make good castings.

The patternmaker receives the drawing from the draughting room, with orders to make a pattern. In looking over this drawing and laying out his lines for the pattern, he notices various features which, to his mind, are not as he thinks they should be. Right here is where the foundryman should be consulted. As a matter of fact, the patternmaker usually turns to the engineer, and between them, the pattern is completed and sent to the foundry.

The Patternmaker.

I am very frank to admit that the patternmaker's ideas may be absolutely along the right lines in many instances, but the direct application of these points can be so modified by the foundryman as to save his making a large amount of defective work, and at the same time not injuring in any way the value of the resulting casting. If, however, the patternmaker consults with the foundryman. and all the points of change are decided upon between them, then let the engineer step in and decide what changes and concessions he can make, and not compromise the value of the machine of which this casting is to become a part. In this way such matters as thickness of metal, sufficient draft, necessary stock on finished surfaces, the advisability of casting separate parts and bolting them together, the question of green sand or dry sand cores, etc., should be considered.

Pattern in the Foundry.

After the pattern has been completed and sample castings have been made and checked, it is then up to the foundry to take up the question of production. Right here is another fine opportunity for the spirit and use of co-operation.

In many instances the foundry superintendent will look the job over and decide at once the rigging to be used in molding the casting in question, determine the size of flask, and suggest changes in the pattern which may have come to his observation in making the sample castings.

In my estimation, this is all wrong. It would be far better to call in the coremaker, the molder, the cleaning room foreman and all who have worked on the first castings, and who, without doubt, have noticed many little details which would help to make good castings. They would be willing and glad to impart their knowledge to the proper individuals. Then, with all this added store of information, the foundry superintendent would be in a vastly better position to decide on the economical and best method of production.

This mode of procedure does not, in any way, detract from the ability of the foundry superintendent. In fact it enhances it, because it shows that his mind is open to improvement and he is willing to learn from the man in more humble circumstances. It is from the minds of our mechanics in the shops that some of the most valuable ideas are suggested.

Making the Casting.

I know of one firm in Detroit, which is paying to its employes one dollar for every idea—however insignificant—which it finds advisable to adopt in its shops. This may seem a small compensation, but it is an incentive to offer suggestions and it also gives the firm a clue as to who is using his brains together with his hands.

When the pattern and rigging are ready, then comes the actual making of the castings. At this stage the foundry superintendent has to decide matters to a great extent himself, without too much consultation with the shop force. This is more or less due, at the present time, to labor conditions and to the fact that a man will turn out an amount of work, under favorable conditions, which almost invariably surprises himself. Thus, in order to get the maximum production of any one job, the foundry superintendent must, from his own experience, gage what should be its output, and work toward that end.

Bonus System.

If a foundry is working on a piecework basis and each molder guarantees his work, the defective castings proposition is much simplified. Under these conditions, the molder is paid only for the good castings which he produces and at a stated price for

*Presented at the Pittsburg convention of the American Foundrymen's Association.

each good casting. This method furnishes a mighty incentive for good work. In some shops in which there is a strong opposition to piecework, a set day's work is established and then a monthly bonus is paid for low percentages of defective work. In one of the largest foundries in the country a bonus of $15 per month is paid to molders whose work shows less than a 2 per cent loss; $12 for less than a 3 per cent loss; $10 for less than a 4 per cent loss; $7.50 for less than a 5 per cent loss and $3.75 for less than a 6 per cent loss. It is amazing to see how many men get the $15 bonus. In this particular case, the bonus creates a strong spirit of co-operation. The foremen in the shop participate in the bonus system, their bonus being made up from an average of all the molders' percentages.

Trouble Men.

In many shops there are what are called *trouble men*. These men look over all defective castings and ferret out causes for defects. They see that changes which would stop these defects are made, and the causes and remedies applied are brought to the attention of all interested in this particular job. These men are indispensable when they are brought up to a high degree of efficiency, especially in a large foundry, where small defects are often allowed to continue, sometimes indefinitely without being remedied.

The melting department of a foundry sometimes has a great deal to do with defective work, although in these days of chemical analysis and the use of the physical laboratory this department has been able to overcome many of its difficulties.

Having once determined the final analysis of the product desired, under normal conditions, it is comparatively easy to obtain practically constant results, because these results depend, more or less, on the operation of a machine in the form of a furnace, rather than almost entirely dependent on the operation of a human being as is the case in the designing office, pattern and molding shops. Aside from dirty metal, which is generally due to poor raw materials, the pouring temperature is the most important item which has to be dealt with; but with the very efficient and practical pyrometers which are now on the market, this determination is again not subject to simply human manipulation.

A clean shop and well cared for equipment tend toward lessening the percentage of defective castings. The cleaning and chipping department of the foundry seldom actually make defective castings, but can often spoil the appearance of good castings by poor grinding or chipping. The value of this department is to turn out as comparatively good looking a casting as it receives from the foundry.

Five Essentials.

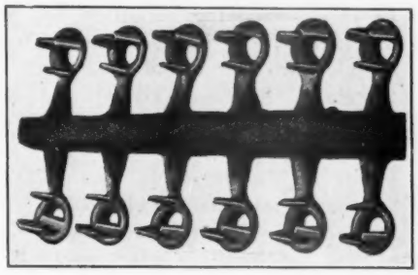
There are five factors essential to a low percentage of bad castings, as follows:

First.—A design from which good castings can be made continuously.

Second.—The combined ideas of all interested in the making of the casting, so as to obtain the best equipment for its production.

Third.—A substantial incentive offered for good work.

Fourth.—Having made a good casting, to insure its shipment in as good condition as when it left the foundry.



GATE OF SMALL STEEL CASTINGS, WEIGHING LESS THAN ONE-FOURTH OUNCE EACH

Fifth.—A clean, well-equipped shop.

Having made castings which are not perfect, where shall the line be drawn between those which for all practical purposes are good and those which must go to the scrap pile? What constitutes good castings? Any foundryman who has run up against government, railroad, or automobile inspectors, will realize the importance of a practical answer to these questions.

I have always contended that these inspectors should be men trained in foundry work. There is not the slightest doubt, but that men, fully competent, can be chosen from the foundrymen's ranks, who will use all necessary caution in inspecting foundry output, who from their intimate knowledge of castings in general will not be influenced by defects which do not impair the efficiency of the castings, and which defects will often appear on account of methods which have to be employed in the foundry at the present time.

In a certain large shop in the east, I have many times heard the statement made that enough castings were scrapped every day to supply an ordinary machine shop. This statement was true. These castings were condemned because the inspector and his superiors did not know the limitations of foundry practice and they worked along lines which it was impossible for the foundry to continuously follow. I do not think this represents an isolated case.

Here is another opportunity and a large one for more co-operation. This time, between the machine shop, through its inspection department, and the foundry; if such can be brought about, it will certainly save many castings from the scrap pile. In this way, the shop will understand the difficulties with which the foundry has to contend and the foundry will work with renewed interest to satisfy the machinist. Welding machines are doing good work in saving castings, the electric machines in steel foundries and oxy-acetylene machines in gray iron and aluminum foundries.

Smallest Steel Casting?

The manufacturers of a recently invented device required a small ring which was provided with three prongs that could be driven through leather, ⅛ inch thick, and clinched on the other side. Efforts were made to cast these rings in malleable iron, but owing to the thinness of the sections, it was found practically impossible to anneal the castings sufficiently so that they would flatten out without breaking. The ordinary steel foundry, says *American Vanadium Facts*, published by the American Vanadium Co., Pittsburg, is not particularly anxious to make castings under 10 pounds in weight and a great many foundries are unable to furnish steel castings weighing less than a pound each. The Sivyer Steel Casting Co., Milwaukee, undertook the problem of making these castings, which weigh only 1/69 of a pound each, or rather less than ¼ of an ounce per casting. What was found to be practically impossible in malleable iron was not only discovered to be practical, but highly successful in vanadium cast steel. A gate of these castings is shown in the accompanying illustration and after being driven through ⅛-inch thickness of leather, the prongs were bent over and flattened almost to a knife edge without showing any signs of fracture. More than 10,000 gates of these castings have been made and the loss and mis-runs approximates only 10 per cent of the total production.

THE BRIQUETTING OF METAL BORINGS*

Description of a powerful hydraulic press used for briquetting cast iron, steel and non-ferrous metal borings

By Richard Moldenke

ONE OF the latest developments in the metal industry in connection with the utilization of metallic waste, is the process of briquetting under enormous pressure without the use of a binding medium. The process was originated by Arpad Ronay, of Buda Pesth, who conceived the idea of imitating nature as closely as possible in the production of rock deposits. He employed extreme pressure, allowing a sufficient time to permit the individual particles to come into intimate contact, excluding thereby spaces filled with air or water which would have a tendency to weaken the bond. When metal particles, as well as ores or other fine materials, are subjected to ordinary pressures, sufficient air is entrained to cause trouble when the briquettes are heated; the air expands, thereby breaking the briquette and resulting in excessive loss and difficulties incident to the use of the fine material, untreated.

*Abstract of a paper presented at the Pittsburg convention of the American Foundrymen's Association.

When the writer was first asked to investigate the process professionally for American interests and before going to Europe, he melted one of the German cast iron boring briquettes in his cupola and left the breast open so that by means of an iron bar, contact could be had with the briquette, from time to time, as it melted. It was found that the briquetted borings melted similar to pig iron and the briquette maintained its shape until the final softening and dropping to the bottom. A visit to the several briquetting installations in Europe showed this industry to be in a flourishing condition and ten plants are now in operation. These include two at Berlin one each at Chemnitz, Stolberg, Cassel and one at the Imperial navy yard at Kiel, Germany. In addition there are plants in Vienna, Buda Pesth, Milan and at Winterthur, Switzerland. In this country the rights to the Ronay process for handling metal waste have been acquired by the Metal Briquetting Co., New York City.

The process may be briefly described as follows: Cast iron, steel, brass, bronze, aluminum, copper chips, borings, filings and metallic slimes after drying, coal, graphite, ore, flue dust, etc., can be satisfactorily briquetted. Borings, before being dumped into the hopper above the press, have the dust and dirt removed by an exhaust fan. This operation likewise removes rust which has become loosened by the rubbing of the particles against each other during transit and the quality of the briquette is thereby greatly inproved. In the case of steel turnings, these are passed through a set of disintegrating rolls to reduce their bulk. After cleaning, the borings are passed over a magnetic separator to remove any brass from the iron. The cleaned and separated borings are then delivered to the feed hopper of the press shown in Fig. 1. The bunker is filled with borings by a bucket elevator and flow by gravity into the plunger of the press and then into the die. As the plunger descends the borings receive their first compression. The air is forced out as the borings are compressed, the separate particles curling into each other. The partially completed briquette in the die is then carried by the revolving table to the next stop where plungers, both from above and below, apply pressures of 35,000 pounds per square inch. The die containing the briquette is free to move up or down at this point, permitting the compressed material freedom to adjust itself to a uniformly distributed force. When the pressure is released, the revolving table makes another turn and the die with the finished briquette, which is slightly conical in shape, is passed under another plunger which forces the briquette out of the die and onto a conveyor by which it is carried away from the machine. All of these movements are entirely automatic, the operation of the press being in charge of one man, a second carrying away the briquettes, while a third has charge of filling the hopper with borings. The briquettes become quite hot during this operation.

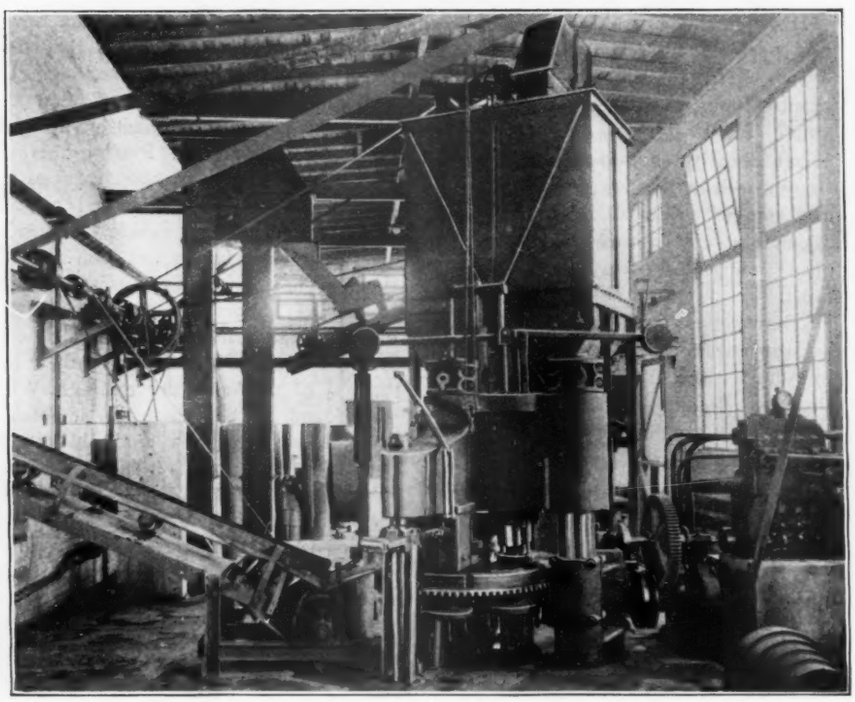


FIG. 1—LARGE PRESS FOR BRIQUETTING BORINGS; CAPACITY, SIX TONS PER HOUR

In Fig. 1 is shown a large press installed at the Chemnitz plant. This has a capacity of six tons per hour and the cost of briquetting, exclusive of royalty, has been reduced to about 50 cents per ton. The cost of a press of this size with conveying apparatus and all accessories, is about $35,000. Fig. 2 shows a large press under construction at the locomotive works of A. Borsig, Berlin. This press is practically completed and ready for shipment and is one of the latest types. A pile of cast iron borings, 6¼ inches in diameter, 7 inches high, and weighing 38 pounds each, are shown in Fig. 3, while in Fig. 4 are illustrated a pile of wrought iron chip briquettes. These briquettes, however, are no longer made in this form.

Use of Briquettes in the Cupola.

The use of briquettes in the cupola is similar to the use of pig iron and heavy scrap, and although the briquettes, in spite of the enormous pressure to which they are subjected, are not as solid as pig iron, melting somewhat more rapidly, their handy shape and weight makes them an ideal cupola charging and melting material. The losses resulting from charging borings directly into the

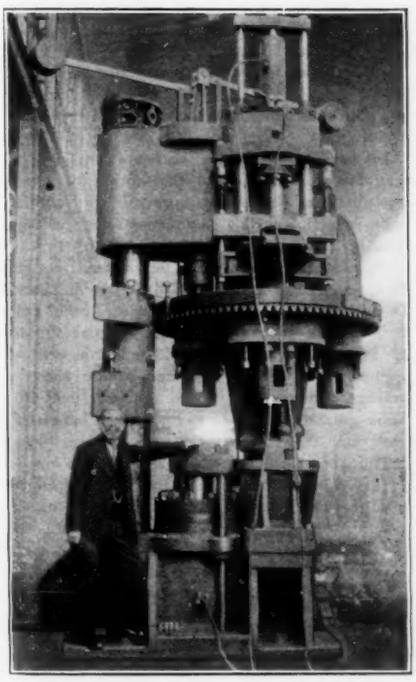


FIG. 2—LARGE PRESS FOR BRIQUETTING BORINGS, ASSEMBLED IN THE MAKER'S WORKS

cupola amount as high as 50 per cent of their weight and when they are boxed, charged in cans or melted in tubes, the melting loss varies between 8 and 12 per cent and there is always danger that the cans or tubes will open, discharging the loose borings over the coke bed. In the case of briquettes as in other melting tests,

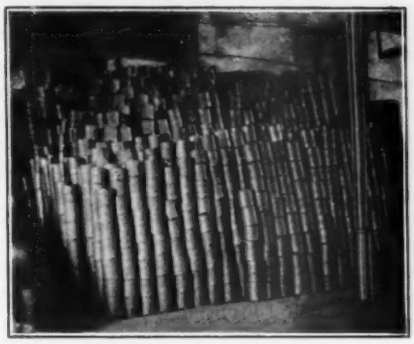


FIG. 3—PILE OF CAST IRON BRIQUETTES, WEIGHING 38 POUNDS EACH

to obtain figures on the process, much depends upon how the melting is done. In melting pig iron with only ordinary precautions, the melting loss may amount to 3 per cent and even more, but when care has been taken in the melting process, the loss has been reduced as low as 1 per cent, and when sandless pig iron was used the losses have been as low as 0.3 per cent. When running straight heats of briquettes, the melting loss with practice that gave 2.5 to 3 per cent loss for straight pig iron, resulted in a loss of 8 to 10 per cent for the briquettes. With careful practice, however, this melting loss can be easily reduced to 6 per cent. When using from 10 to 80 per cent of briquettes, the remainder of the charge being pig iron, the melting loss of the heat will be about normal. In one heat containing 80 per cent of briquettes and 20 per cent of pig iron, the actual melting loss was only 3.5 per cent.

Metallurgical Changes.

There are some metallurgical changes in melting borings, whether loose or briquetted, which must be considered. The silicon will be lowered considerably more than is ordinarily the case, the total carbon will be decreased, while the sulphur will increase about twice the ordinary amount. This, of course, is only noticeable when the heat consists entirely of briquettes. When briquettes, however, form only a part of the charge, only slight metallurgical changes are noticeable and castings such as cylinders for gas and steam engines, etc., show a marked improvement when briquettes are used in the charges. A reduction in the total carbon and silicon corresponds to a steel addition to the charge and this accounts for the improvement in these castings. The slight increase in sulphur imparts a structure more finely granular and gives a better wearing surface for cylinder work. Inasmuch as the large locomotive works on the continent are adopting the use of briquettes, it is evident that the use of borings is not a detriment. In Germany these briquettes are actually sold at pig iron prices and at the Borsig Locomotive Works, the regular charges for steam and gas engine cylinders, refrigerating machinery castings and castings for hydraulic machinery, air compressors, superheated steam and steam turbine apparatus, contain 40 per cent of briquettes.

Briquettes for Semi-Steel.

Perhaps one of the most interesting applications of the briquetting process involves the mixing of steel with the cast iron borings. This affords an excellent method of charging steel into the cupola without burning a portion of the steel before melting. The contact of a low carbon with a high carbon material means the melting down of this combination with an average carbon content. In place, therefore, of adding 40 per cent of steel scrap to the charge and in melting to obtain, per-

FIG. 4—PILE OF WROUGHT IRON CHIP BRIQUETTES

haps, a reduction in carbon in the castings corresponding to one-half of this as a result, either much less steel need be added to the borings for briquetting, or if the full amount is added, a much stronger metal is obtained. The foundryman, therefore, is in position to utilize any steel

scrap he may produce and, in addition, he may order his briquettes with the exact proportion of steel he wants them to contain. For air or open-hearth furnace work, all-steel briquettes give better results than heavy steel scrap. They not only melt faster, thereby shortening the heat considerably, but their uniform size and shape permits them to be piled in the furnace, allowing a better circulation of the gases than can be obtained by the use of irregular and large pieces of scrap. The melting losses of briquetted brass, bronze, aluminum, white metal and other nonferrous borings are about the same as the solid metal when melted. The softer metals and alloys are pressed together so closely, that for all practical purposes, they constitute sound pieces of metal. The finer the scrap the better the briquette and hence a magnificent field has been opened for the economical recovery of these expensive metals in the foundry.

Standard Specifications for Locomotive Cylinders and Manganese Bronze Ingots

STANDARD specifications for spelter, manganese bronze ingots and for copper wire bars, cakes, slabs, billets, ingots and ingot bars, were favorably considered at the annual meeting of the American Society for Testing Materials, held recently at Atlantic City, and will be referred to the membership for letter ballot for their final adoption.

Under the spelter specifications, virgin spelter is considered to be made from ore or similar raw material by a process of reduction and distillation and is not to be produced from re-worked metal. Spelter is divided into four grades as follows: (a) high grade, (b) intermediate, (c) brass spelter and (d) prime western. High grade spelter shall not contain over 0.07 per cent lead, 0.3 per cent iron, 0.50 per cent cadmium and shall be free from aluminum. The sum of the lead, iron and cadmium shall not exceed 0.10 per cent. The intermediate grade shall not contain over 0.20 per cent lead, 0.03 per cent iron, 0.50 per cent cadmium and shall be free from aluminum. The sum of the lead, iron and cadmium shall not exceed 0.50 per cent. The brass spelter shall not contain over 0.75 per cent lead, 0.04 per cent iron, 0.75 per cent cadmium and shall be free from aluminum. The sum of the lead, iron and cadmium shall not exceed 1.20 per cent. Prime western spelter shall not contain over 1.50 per cent lead and 0.08 per cent iron. The methods of sampling and making analyses are also covered.

Standard specifications for copper wire bars, cakes, slabs, billets, ingots, etc., provide that the copper in all shapes shall have a purity of at least 99.88 per cent as determined by electrolytic assay, silver being considered as copper. All wire bars shall have a conductivity of at least 98.5 per cent, annealed, and all ingots and ingot bars shall have a conductivity of at least 97.5 per cent, annealed, with the exception only of arsenical copper, which shall have a conductivity of not less than 90 per cent, annealed. These specifications, however, do not take into consideration casting copper used for the purpose of alloying with other metals to produce cast shapes.

Specifications for Manganese Bronze Ingots.

The proposed standard specifications for manganese bronze ingots are presented herewith:

1.—This specification is intended to cover manganese bronze ingots, having notched flat bottoms, approximately 3 by 2¾ inches wide by 12 inches long, properly tapered to strip easily from an iron mold. Chemical composition:

	Per cent.
Copper	55 to 60
Zinc	39 to 45
Tin not over	2
Aluminum not over	0.5
Manganese not over	0.5
Iron not over	2

2.—The ultimate tensile strength shall be not less than 70,000 pounds per square inch.

The elongation in 2 inches shall be not less than 20 per cent.

3.—A standard turned test specimen, 0.5 inch in diameter and 2 inches gage length, shall be used to determine the physical properties as specified above.

4.—One test ingot shall be selected by the inspector to represent 10,000 pounds of ingots or fraction thereof. The test specimen shall be cut from one corner near the bottom of the ingot. In case the test specimen shows a flaw, two additional tests may be selected by the inspector from the same lot, and tested to represent the lot in question.

5.—Each furnace charge shall be kept separate until the lot is sampled by the inspector, and each ingot thereof stamped with its proper heat number. When the ingot is sampled at destination, various heats can be mixed in shipment, but must be stamped with their proper heat number.

6.—All ingots in each lot will be accepted or rejected upon the physical tests irrespective of the heat or heats from which the test ingots are selected.

In case the buyer's tests show the material does not meet these specifications, the sellers shall have an opportunity to inspect the material, and each party shall select a sample for retest. If the results do not agree, each shall select a sample to be sent to a mutually agreeable umpire, whose decision shall be final. The costs of such retest shall be paid by the loser.

Specifications for Locomotive Cylinders.

The committee on standard specifications for cast iron and finished castings, of which Walter Wood was chairman and Dr. Richard Moldenke was secretary, presented revised standard specifications for locomotive cylinders, which are as follows:

1.—Locomotive cylinders shall be made from good quality, close-grained gray iron, cast in a dry mold.

2.—Drillings taken from test pieces as hereafter mentioned shall conform to the following limits in chemical composition:

	Per cent.
Phosphorus	Not over 0.90
Sulphur	Not over 0.10

In case of rejection on this analysis, the manufacturer shall have the option of analyzing drillings from the bore of the cylinder, upon which analysis the acceptance or rejection of the cylinder shall be based.

At the option of the purchaser, two test bars, each 1¼ inches in diameter and about 14 inches long, may be cast for each cylinder. When placed horizontally upon supports 12 inches apart and tested under a centrally applied load, these test bars shall show an average transverse strength of not less than 3,000 pounds, and an average deflection not less than 0.09 inches.

The above test pieces shall be cast on end in dry sand, the metal being taken from the ladle before pouring into the cylinder mold.

Before pouring, a sample of the iron shall be taken from the ladle and chilled in a cast iron mold.

The sample shall be allowed to cool in the mold until it is dark red, or almost black, when it shall be knocked out and quenched in water. The sample, on being broken, must show a close-grained, well mottled gray iron, with a well-defined border of white iron at the bottom of the fracture.

Castings shall be smooth, well cleaned, free from blow holes, shrinkage cracks, or other defects sufficiently extensive to impair the value of the casting, and must finish to blue print size.

Each cylinder shall have cast on each side of the saddle the manufacturer's mark, serial number, date made, and mark showing order number.

The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy himself that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of the manufacturer.

Porous Cylinder Heads

By N. W. Shed

Question:—We are experiencing considerable trouble in obtaining solid cylinder heads. A large number of these castings are porous and leak. We use No. 2 foundry iron and good agricultural scrap and the mixture consists of 35 per cent pig metal and 65 per cent scrap. Our melting ratio averages 1 to 10. We have varied the amount of pig iron and scrap, but the results have not been satisfactory.

Answer: — This mixture carries too much scrap and as a result the sulphur content is too high. The metal is too soft for good cylinder heads and an insufficient amount of coke is used to insure hot iron. Reduce the coke ratio to 1 to 8 and use 50 per cent of No. 2 foundry iron, 15 per cent of steel scrap and 35 per cent of ordinary scrap. Add a few pounds of ferromanganese to the charge of steel scrap. This mixture should give a close-grained iron. If nails are driven into the mold near the corners, the iron will chill around the heads of the nails and this is usually effective with a one-half pig and one-half scrap mixture. If any part of the head is spongy, a few nails driven into the mold at that point will result in a solid casting.

Hard Iron from the Last of the Heat

By W. J. Keep

Question:—After the first two or three charges, the iron from our cupola begins to cool and comes dirty. We light the cupola at about 12 o'clock. The bed consists of 1,000 pounds of coal and 200 pounds of coke, and reaches a height of about 20 inches above the tuyeres. At 1 o'clock we begin charging the iron, scrap, etc., and at 1:45 we shut off the draft and hold the fire back until the blast is put on at 3 o'clock. Does the fact that we hold the fire back have any effect on the dull iron tapped from the cupola during the latter part of the heat? We melt five to five and a half tons an hour at a ratio of one of iron to five and a half of coke. Our cupola is 42 inches in diameter. Our method of charging follows: Bed, 1,000 pounds of coal and 200 pounds of coke; first charge 1,600 pounds of pig iron, 1,600 pounds of gates and miscellaneous scrap and 200 pounds of coke; second charge 1,200 pounds of pig iron, 1,000 pounds of gates and miscellaneous scrap and 200 pounds of coke; third charge, 1,200 pounds of pig iron, 1,000 pounds of gates and miscellaneous scrap and 200 pounds of coke; fourth charge, 800 pounds of pig iron, 1,200 pounds of gates and miscellaneous scrap and 100 pounds of coke; fifth charge, 1,400 pounds of gates and miscellaneous scrap.

Answer:—Your difficulties might be overcome by reducing the coke on the bed and adding this fuel to the last four charges. Your melting ratio approximates one to 6.3, which is fair practice for a 42-inch cupola with so small a heat. The distance of the tuyeres from the sand bottom is small and the fuel should not extend more than 18 inches above the tuyeres. The usual practice is to make the ratio of iron to coke in charges after the first heat, 10 to one, and your coke charges would thereby be increased to 260 instead of 200 pounds. We would suggest that you add 50 pounds of coke to the second, third and fourth charges. If the last iron is not sufficiently soft, increase the silicon content of the iron in the last charges. As a rule, iron from the last of the heat is softer than that from the first part of the heat, owing to the fact that the cupola is hotter.

The Growth of Cast Iron

IN A previous paper delivered before the Iron and Steel Institute, London (Eng.), and briefly presented in the July, 1911, issue of THE FOUNDRY, Prof. H. C. H. Carpenter discussed the influence of carbon, silicon and absorbed gases on the growth and disintegration of cast iron under the influence of repeated heatings. The results of further investigations of this subject, which include the effect of sulphur and phosphorus, as well as the practical application of the results obtained in determining the correct analysis of an iron free from growth, and, therefore, suitable for such castings as rolls, ingot molds, annealing boxes, etc., are given in a second paper presented before the Iron and Steel Institute by Dr. Carpenter, in which it is stated that phosphorus does not cause an increase in ultimate growth of iron, but a marked diminution. The tests showed that an iron containing total carbon, 3.98 per cent; graphitic carbon, 3.34 per cent; combined carbon, 0.64 per cent; silicon, 1.07 per cent; manganese, 0.25 per cent; sulphur, 0.01 per cent and phosphorus. 0.013 per cent, grew 16.10 per cent in 18 heatings, but with the phosphorus increased to 0.858 per cent, the growth, with 29 heatings, was but 13.31 per cent.

Effect of Sulphur.

In the case of sulphur, in view of the fact that this element is invariably low, rarely reaching 0.2 per cent, it was decided that this element had no appreciable effect on the growth of iron. It was found that manganese retarded the growth of iron even when silicon was comparatively high, but that the lower the silicon, the greater the diminution, which conclusions were confirmed by a series of experiments. The influence of dissolved gases in promoting growth was found to be considerable, and in close gray irons which do not contain more than ½ per cent of silicon the pressure of absorbed gases is responsible for a large portion of the growth observed. Graphite is indirectly essential to growth, as it forms a channel by means of which the gases consisting principally of hydrogen and nitrogen, are enabled to penetrate the metal.

Silicon Promotes Growth.

Silicon, in combination with iron and present as iron silicide, is undoubtedly the most potent factor in causing growth, while combined carbon is only slightly contributory. Phosphorus diminishes the rate of growth and sulphur, in combination with either iron or manganese, also has a retarding effect.

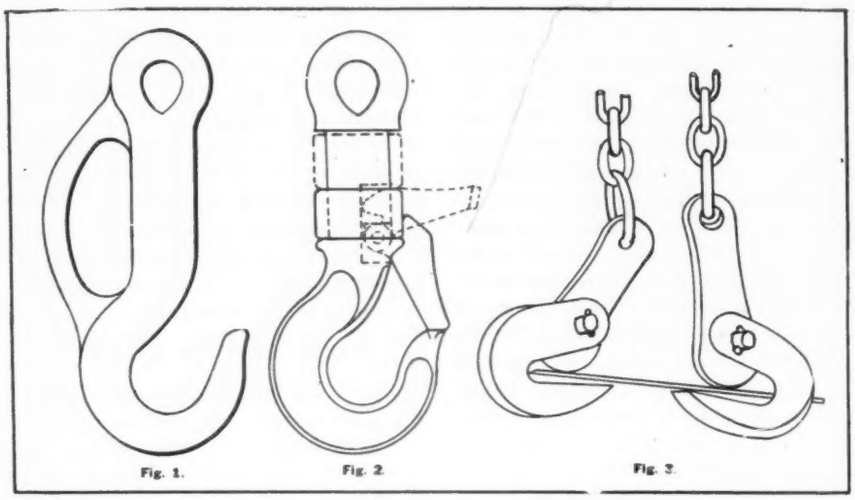
The conclusion reached as a result of these experiments was that there is no such thing as a gray iron that will not grow when repeatedly heated to redness in the presence either of furnace gases or air. All that can be done is to estimate the growth that may be anticipated in an iron whose chemical composition is known.

It was recommended that white irons be used instead of gray for annealing boxes, and the most suitable composition appeared to be an iron containing about 3 per cent of carbon and as free from all other impurities as possible. Of these, silicon is the most important, and should not exceed 0.2 to 0.3 per cent. Such an iron would probably shrink on repeated heating. The reason why

an upper limit of 3 per cent of carbon is suggested, is that irons higher in carbon will tend to deposit temper carbon, in which case the material will begin to grow, although it will not proceed to the extent of gray iron. This recommendation, it was pointed out by other Institute members, would be difficult to follow, because irons so low in silicon were hard to obtain, 0.5 per cent being about the lowest point at which this constituent could be obtained in practice, and even if obtainable, the castings could not be prevented from cracking when heated, which was due to the fact that whether made in chills or sand, such castings had a pronounced crystalline structure, the crystals being arranged at right angles to the cooling surfaces of the mold. Therefore, unless free from sharp angles, and well-fed and clean at the gates and feeders, such castings crack when rapidly heated. The experience of another member, however, showed that such an alloy could be used in the case of chills, as after trouble had been experienced with gray iron, which grew and produced a distortion of the casting on which the chills were used, new chills were made of an iron similar in composition to that given, with very satisfactory results.

A Mild Steel Free from Growth.

A mild steel which did not grow, but tended to slightly shrink, had the following analysis: Carbon, 0.15 per cent; silicon, 0.186 per cent; manganese, 0.15 per cent; sulphur, 0.040 per cent and phosphorus, 0.017 per cent. An iron which contained carbon, 3.02 per cent; silicon, 0.50 per cent and manganese, 0.86 per cent, was found to contract for about 10 heatings, after which it slowly grew, attaining a maximum growth of 2.54 per cent in 50 heatings. This was considered as indicating the beneficial influence of manganese in diminishing growth, and after several experiments had been made on iron of differing manganese content, an iron of the following composition was evolved: Carbon, 2.50 per cent; manganese, 1.50 per cent; silicon, 0.50 per cent; sulphur, 0.01 per cent and phosphorus, 0.01 per cent. This iron contracted slightly but steadily for 72 heats, the amount being 0.39 per cent, after which the contraction continued in a diminished degree. This, therefore, may be regarded as a non-growing iron that could be tried with advantage for casting rolls, grate bars, muffle furnace grids and annealing boxes, where growth is such an annoying characteristic. It could also be used for ingot molds, but it is doubtful if it would withstand molten steel. For this purpose the mild steel, previously mentioned, would prove more economical, for although the first cost is greater, it is less likely to crack than the semi-cast iron and its growth would probably be negligible. No doubt a gray iron containing plenty of graphite would be less liable to crack, but no treatment is known that would prevent its growth when heated. The investigation did not result in the discovery of an iron whose volume would be absolutely unaltered after repeated heatings as there is either growth or shrinkage, but for practical purposes it is assumed that a growth of 0.5 per cent is permissible.



TYPES OF SAFETY CRANE HOOKS

Safety Crane Hooks

Three types of crane hooks equipped with safety devices have been adopted by the United States Steel Corporation through its department of safety, and are in use in the works of the National Tube Co. In Fig. 1, is shown a crane hook equipped with a handle, the purpose of which is to avoid the necessity of the operator grasping the hook near the bight when picking up a load, and thus obviates the danger of hands or fingers being caught and mangled. In Fig. 2, a hook is shown fitted with a latch to close the opening to prevent the load falling out, or the possibility of the hook slipping off. This safety latch is prevented from opening by means of a collar which slides on the shank of the hook, and is raised to open the latch, but will not fall and lock the latter unless it is in contact with the tip of the hook. It thus indicates whether the load is securely held by the hook as well as prevents all possibility of either load or hook slipping, except by the exertion of force sufficient to bend or displace the latch. A defect of this type of hook, viewed from a safety standpoint, is the lack of a handle similar to that which distinguishes Fig. 1, and an improvement that might be suggested would be to incorporate the two hooks into one.

In Fig. 3 is shown a pair of toggle hooks for handling plates. These hooks consist of a combination of a flat link and a hook, hinged together in such a manner that one end of the link extends into the hook opening and forms a cam that bites the plate under the strain of the load, so that the heavier the latter the more firmly the plate is held. This pinch effect is produced by making the lower hole of the link eccentric. Therefore, any force that tends to pull the link into a vertical position causes the end to turn and narrow the opening of the hook.

Buffalo Foundry Foremen

At the annual meeting of the Buffalo Foundry Foremen's Association, officers for the ensuing year were elected as follows: President, Richard Lau, Lumen Bearing Co.; vice president, C. G. Falkenberg, American Malleables; secretary, Robt. B. Thomson, Buffalo Pitts Co., and treasurer, G. C. Devitt, Buffalo Scale Co. A committee was also appointed to provide entertainment for the visiting foundry foremen during the 1912 convention of the American Foundrymen's Association.

MALLEABLE ANNEALING TEMPERATURES*

A discussion of the chemical and physical properties of malleable sections with results of annealing experiments

By W. P. Putnam

WHILE the characteristics of malleable castings are generally well known to the manufacturers of these sections, the users of malleables are not so conversant with the problems involved in their manufacture. The results of work done on the annealing of malleable iron here recorded, may throw some light on the difficulties that must be overcome in the manufacture of high grade malleable castings. After the iron has been properly melted and cast, the foundryman's troubles are about half over. If the castings are large and are not to be machined, the annealing process does not present unusual difficulties. On the other hand, if the castings are small and must be machined, the annealing process must be watched closely to avoid ruining good material. While it is impossible to correct all of the mistakes made in the melting room, it is possible to spoil, beyond recall, good metal by improper annealing. The evidence presented herewith, covers a number of years of experiment and research.

The woeful indifference sometimes displayed in equipping annealing ovens with pyrometers is, in a great measure, responsible for a large percentage of rejected castings. In beginning this work, I first realized that very little headway could be made without first knowing something of the physical structure of malleable iron, as well as its chemical characteristics. Of course, the importance of melting and molding should be given proper weight, but the annealing process is one that should be given careful consideration. The proper annealing temperatures, shown in Fig. 5, were experimentally determined by placing a pyrometer inside of pots filled with castings containing varying percentages of carbon. These temperatures were subsequently checked by annealing a full oven with similar metal. When the percentages of carbon are known and by using a pyrometer, the results can be duplicated at any time without much variation. Figs. 6, 7, 8 and 9 show the results obtained in annealing hard iron or white cast iron in a commercial way; particular attention is directed to the uniformity of results and in every case the castings were satisfactory.

*Presented at the Pittsburg convention of the American Foundrymen's Association.

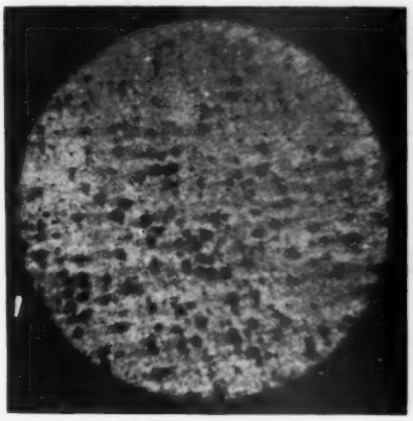


FIG. 1—MICRO-PHOTOGRAPH OF OUTSIDE OF MALLEABLE CASTING, SHOWING GRAPHITE

The annealing results recorded in Fig. 2 are of white iron, which analyzed as follows: Silicon, 0.74 per cent; sulphur, 0.064 per cent; phosphorus, 0.182 per cent; manganese, 0.35 per cent, and combined carbon, 2.80 per cent. This iron, when annealed, had the following analysis: Silicon, 0.78 per cent; sulphur, 0.068 per cent; phosphorus, 0.18 per cent; manganese, 0.31 per cent; combined carbon, 0.25 per cent, and graphitic carbon, 1.62 per cent.

In Fig. 7 are shown the temperatures at the back wall of the oven, at the door of the oven and of a pot near the door of the oven. It will be noted that the temperature of the back wall of the oven considerably exceeded that at the door of the oven. The castings near the top of the pot, located near the door of the oven, contained a trace of combined carbon and 1.38 per cent of graphitic carbon, while at the bottom of the pot the castings contained 1.54 per cent of graphitic carbon and only a trace of combined carbon.

Fig. 8 records the temperature of the oven at the greatest distance from the firebox and also the firebox temperature. The percentages of graphitic carbon contained in the castings taken from the top of seven pots, follow: 1.51, 1.78,

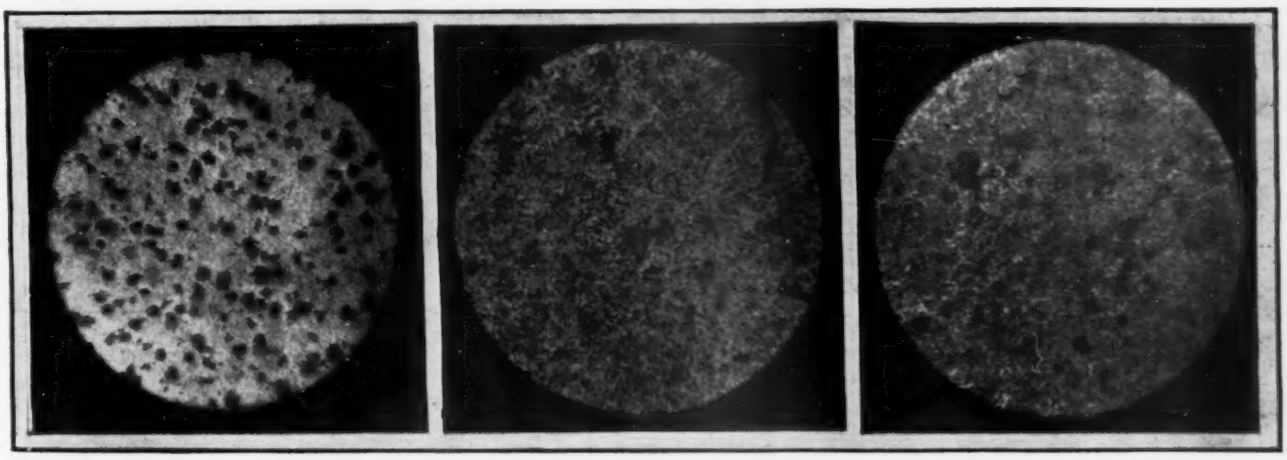


FIG. 2—MICRO-PHOTOGRAPH OF CENTER OF WELL-ANNEALED CASTING, SHOWING GRAPHITE

FIG. 3—OUTSIDE OF BAR, RE-HEATED AFTER ANNEALING, SHOWING CEMENTITE

FIG. 4—CENTER OF BAR, RE-HEATED AFTER ANNEALING, SHOWING GRAPHITE AND CEMENTITE

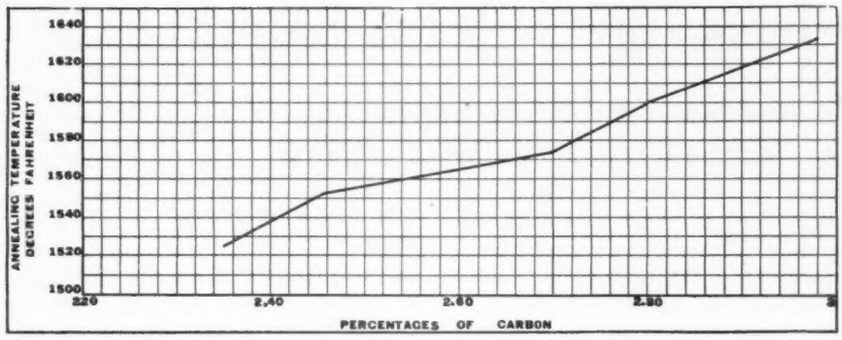


FIG. 5—PROPER ANNEALING TEMPERATURE FOR MALLEABLE CASTINGS

1.68, 1.72, 1.86, 1.60, 1.68; the average percentage of graphitic carbon was 1.68. The graphitic carbon in the castings in the bottom of these pots was of the following respective percentages: 1.65, 1.77, 1.69, 1.88, 2.00, 1.89 and 1.81. The average graphitic carbon per cent contained in the castings at the bottom of the pot was 1.81. As compared with the tops of the pots, this shows an average increase in graphitic carbon of the castings contained in the bottoms of the pots of 0.13 per cent.

Fig. 9 records the annealing temperature inside of a pot containing high sulphur castings. The white iron as charged analyzed as follows: Silicon, 0.68 per cent; sulphur, 0.17 per cent; phosphorus, 0.186 per cent; manganese, 0.24 per cent, and combined carbon, 2.60 per cent. After the first anneal, during which the oven temperature was raised to 1,600 degrees Fahr., the castings analyzed as follows: Silicon, 0.67 per cent; sulphur, 0.177 per cent; phosphorus, 0.190 per cent; manganese, 0.21 per cent; combined carbon, 0.92 per cent, and graphitic carbon, 1.26 per cent. After the second anneal and with a maximum oven temperature of 1,575 degrees Fahr., the analysis of the castings was as follows: Silicon, 0.59 per cent; sulphur, 0.167 per cent; phosphorus, 0.186 per cent; manganese, 0.24 per cent; combined carbon, 1.00 per cent, and graphitic carbon, 0.88 per cent. After the third anneal and a maximum oven temperature of 1,600 degrees Fahr., the analysis of the castings was as follows: Silicon, 0.57 per cent; sulphur, 0.183 per cent; phosphorus, 0.189 per cent; manganese, 0.27 per cent; combined carbon, 0.40 per cent, and graphitic carbon, 0.65 per cent.

Table I gives the analyses of four samples of over-annealed malleable iron, and in Table II the changes due to annealing a ¾-inch square bar, three times, are recorded. In Table III are given the chemical analyses and physical tests of four samples of malleable iron. These clearly illustrate some of the differences between good and bad malleable castings. Bar No. 1 was well annealed, but weak, due to a heavy draw or shrink which extended one-quarter the distance through the bar; bar No. 2 was over-annealed, but exhibited good physical qualities; bar No. 3 was under-annealed and contained a high percentage of silicon; bar No. 4 was over-annealed, but was solid throughout, and bar No. 5 was the same as bar No. 4, but was re-heated to a temperature of 1,600 degrees Fahr., after annealing. Carbon was reabsorbed in the form of cementite.

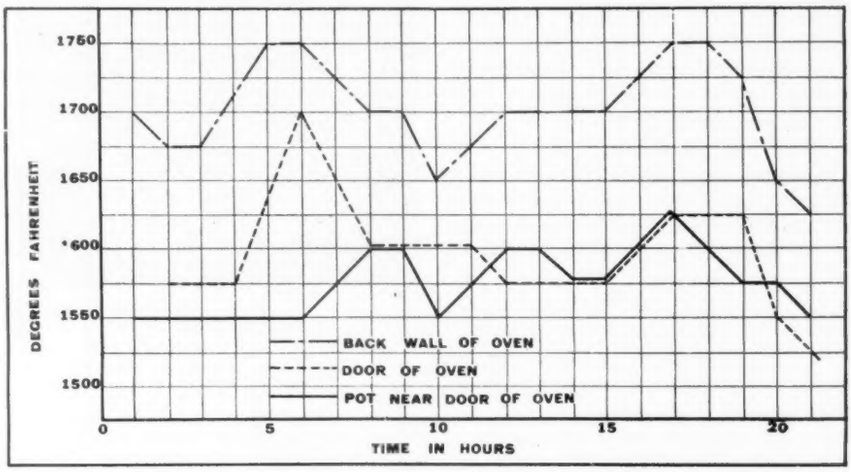


FIG. 7—ANNEALING TEMPERATURES AT THE BACK WALL OF THE OVEN, DOOR OF OVEN AND OF A POT NEAR THE DOOR OF THE OVEN

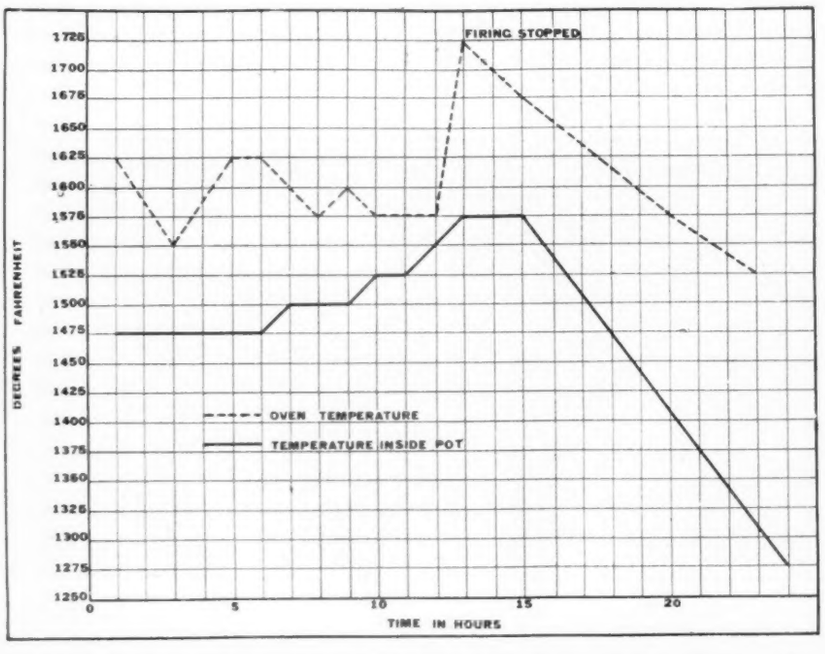


FIG. 6—RECORD OF TEMPERATURES INSIDE OF THE OVEN AND INSIDE OF A POT

Table I

OVEN-ANNEALED IRON.

	Per cent.	Per cent.	Per cent.	Per cent.
Silicon	0.52	0.60	0.60	0.53
Sulphur	0.062	0.063	0.059	0.069
Phosphorus	0.175	0.174	0.195	0.190
Manganese	0.31	0.32	0.24	0.23
Combined carb.	Trace.	Trace.	Trace.	Trace.
Graphitic carb.	0.84	0.49	0.48	0.03

In Fig. 1 is shown a micro-photograph of the outside of a malleable casting, which clearly illustrates the graphite contents. Fig. 2 is the micro-photo-

graph of a section from the center of a well-annealed casting, showing graphite. Fig. 3 is the micro-photograph of the outside of a bar that has been re-heated to 1,600 degrees Fahr, after annealing, and shows cementite. Fig. 4

Table II

THE EFFECT OF ANNEALING A ¾-INCH SQUARE BAR THREE TIMES.

	First anneal. Per cent.	Second anneal. Per cent.	Third anneal. Per cent.
Silicon	0.68	0.70	0.78
Sulphur	0.052	0.052	0.052
Phosphorus ...	0.186	0.188	0.187
Manganese	0.28	0.30	0.27
Combined carbon	Trace.	Trace	Trace
Graphitic carbon.	1.97	0.73	0.25

is the micro-photograph of the center of a bar that has been re-heated to 1,600 degrees Fahr. after annealing and shows both graphite and cementite.

High Tensile Iron

By N. W. Shed

Question:—We would like to make cast iron that will give a tensile strength of 25,000 pounds per square inch and would like to know what kind of a mixture to use to obtain iron that will conform to these requirements. The pig iron that we are now using analyzes as follows: Silicon, 2 to 2.50 per cent; sulphur, not over 0.05 per cent; phosphorus, not over 0.20 per cent, and manganese, not over 1 per cent.

Answer:—A cast iron that will give a tensile strength of 25,000 pounds per square inch is frequently made from an ordinary soft mixture. Occasionally the silicon is largely oxidized and the graphite comes low, resulting in a strong iron. When desiring a strong iron, foundrymen frequently use a regular car wheel mixture, or use car wheels for the bulk of the charge. A car wheel iron will often run about 30,000 pounds in tensile strength. For high grades of strong iron, charcoal iron is used extensively. A substitute is now being made by using steel scrap, which reduces the cost. To obtain good results, it is essential to know the analysis of the material and to endeavor to obtain a uniform, low silicon content. With a pig iron of 2 to 2.5 per cent silicon, use approximately 30 per cent pig, 30 per cent charcoal iron or car wheels, 20 per cent steel and 20 per cent machinery scrap. The charcoal iron should be low in silicon. Some foundrymen use pig iron and 40 per cent steel scrap, but the majority cannot obtain good results by using such a high percentage of steel. It is good policy to keep the manganese high, 1 per cent of ferro-manganese melted with the steel scrap being sufficient.

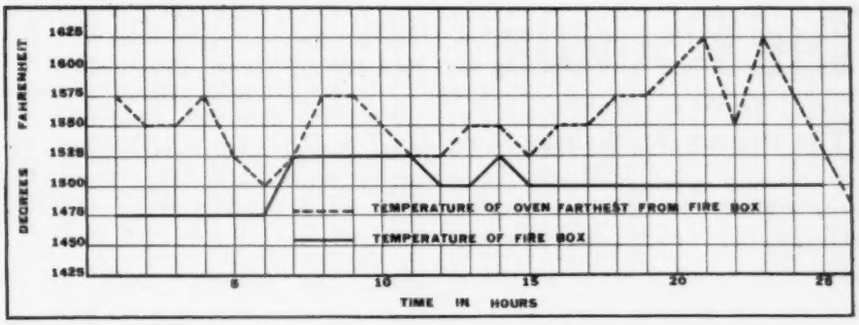


FIG. 8—TEMPERATURES OF ANNEALING OVEN AT THE GREATEST DISTANCE FROM THE FIREBOX, AS WELL AS THE FIREBOX TEMPERATURE

Cracks from Unequal Shrinkage

By W. J. Keep

Question:—We are experiencing considerable trouble with small castings which crack when cooling. We tried stripping the heavy rib which extends through the center of the casting, but unfortunately this did not overcome our difficulty. The casting varies in thickness considerably. Our iron analyzes as follows: Silicon, 2.30 per cent; manganese, 0.70 per cent; total carbon, 3.30 per cent; phosphorus, 0.75 per cent, and sulphur, 0.12 per cent. The sulphur in our mixture is 0.08 per cent.

Answer:—Reduce the sulphur, either by using iron and coke low in sulphur, or by adding less or better scrap to your mixture. If this is an ornamental casting the pattern can be changed to insure a more uniform thickness. For immediate relief place a chill in the cope the width of the center bar and we would suggest placing the chill in the drag but for the fact that the casting appears to be highly ornamental in this part. By the use of the chill the center bar will cool as quickly as the side bar. At present the outside bar is cooled and becomes solid, while the center bar is still fluid. When it, in turn, becomes solid and shrinks it necessarily grows shorter and the long sides will either warp or the ends must crack.

Table III

Bar No.	Silicon.	Sulphur.	Phosphorus.	Manganese.	Combined carbon.	Graphitic carbon.	Elastic limit, pounds per square inch.	Tensile strength, pounds per square inch.	Reduction of area, per cent.	Elongation, per cent.
1	0.78	0.053	0.154	0.29	Trace	1.89		36,086		
2	0.65	0.048	0.165	0.34	Trace	0.80	28,888	40,666	14.22	7.03
3	0.96	0.098	0.060	0.28	0.12	0.94	78,520	78,520		
4	0.74	0.056	0.154	0.40	Trace	0.83	37,195	53,283	15.62	21.38
5	0.74	0.056	0.156	0.40	0.60	0.20				

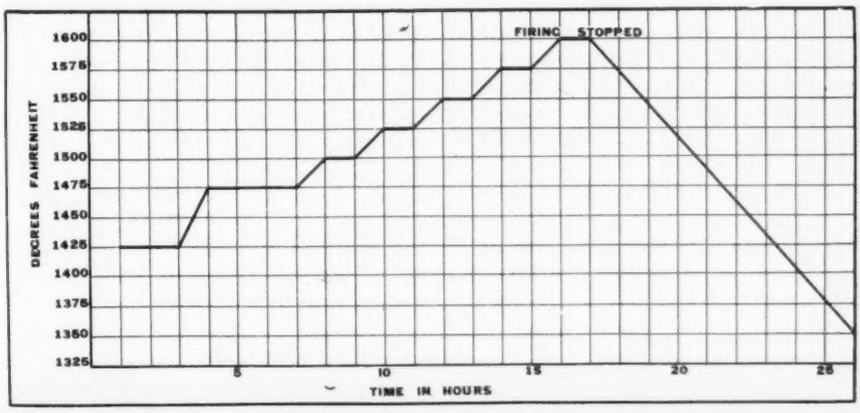


FIG. 9—RECORD OF TEMPERATURE INSIDE OF A POT

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The Coming New Metal

While the consumption of magnesium in the United States has remained almost stationary for the past two years, there is every indication that its use will be greatly extended in the near future, as it seems probable that a material reduction in price will soon be made. In this respect the history of magnesium will probably closely follow that of aluminum, which, from a rarity, is rapidly becoming one of the most common of metals, and this almost within a generation. In some respects magnesium has the advantage of aluminum, as its specific gravity is less, and when properly alloyed the metal is equally as strong. New uses are being continually found for magnesium, both as a metal and as a deoxidizer of other metals, one of its more recent applications in this latter capacity being in the refining of steel, in which respect it is claimed to be superior to aluminum. The total annual consumption of magnesium in the United States has not exceeded $12,000 in value, and its price per pound has for some time been $1.50 in 100-pound lots. A new process of manufacture, now being perfected, will, it is expected, greatly reduce the cost of production, and may result in reducing the price as low as 50 cents per pound. At this figure magnesium will become a strong competitor of aluminum for many purposes where lightness is desirable.

Trouble Men

Losses in foundry operations are largely measured by the percentage of defective castings produced. All efforts are concentrated in the production of sound work and failure frequently involves the entire shop working force. As a rule, however, the molder is the first to be burdened with such losses and in many foundries, systems have been adopted which prove an incentive for good work. A monthly bonus paid to the molders for low percentages of bad work has greatly reduced these losses in many shops and wherever this method has been adopted the bonus for losses below 2 per cent is being paid to an amazingly large number of men. To further arouse the spirit of co-operation, the foremen participate, their bonus being made up from an average of all of the molders' percentages. So much for the molder. While apparently not directly involved, to the management of the shop can be attributed a large share of the burden contributing to heavy losses. Inadequate rigging, limited crane facilities and even poor lighting and ventilation are causes beyond the molder's control that result in many defective castings for which the management is directly responsible. Provided with adequate tools, a well-equipped shop and congenial surroundings, the average skilled molder will do his part in maintaining a low percentage of losses. In an able paper on this subject presented before the American Foundrymen's Association and published elsewhere in this issue, reference is made to the employment of *trouble men*. It is their duty to inspect all defective castings and to ferret out the causes leading to bad work. It is their duty to see that changes are made that will prevent a continuation of defective work and the suggested remedies are brought to the attention of all interested in a particular job. These men are indispensable, especially in large foundries where small defects are frequently overlooked, but which are responsible for high percentages of defective castings.

Trade Outlook

Increased activity in pig iron at lower values than have prevailed for several years, is reported from all leading centers. The buying of foundry iron reflects a slightly increased melt as well as depleted stocks in foundry yards. One of the gratifying features of the situation is the reduction of stocks in blast furnace yards and the greatest inroads have been made at merchant stacks. Steel works, generally, are operating at increased capacity and the unfilled tonnage for all kinds of steel products continues to increase. To some extent, the foundry trade has shared in this improvement, although malleable and steel casting shops are operating at approximately one-half capacity. This is largely due to the limited buying of the railroads which covers only current requirements and extensive replacement and improvement expenditures are deferred, except in cases of necessity. The extreme heat which prevailed throughout the country during the early part of July greatly retarded foundry operations and many plants were forced to shut down temporarily. The foundry trade is now in the midst of the usual summer lull, yet the operating capacity has not materially declined, nor have the foundries suffered to as great an extent as in former years. The present outlook, in the absence of large undertakings, foreshadows only normal improvement during the fall months and at a rate which will keep pace with the increased activity in the

steel trade. Gray iron specialty shops, aside from those running on railroad work, have not been greatly affected by existing trade conditions and the jobbing shops, in some centers, are unable to obtain sufficient skilled help. Brass and aluminum shops, particularly those specializing in automobile work, are pressed for deliveries and the growth in the volume of this business, to a large extent, is due to the development of the motor truck. Orders for castings for cars for the 1912 season, have largely been placed and they involve a tremendous tonnage of brass and aluminum sections, while the steel foundries engaged in the manufacture of small work have received large orders for alloy steel castings. Pig iron values have declined from 25 to 50 cents per ton and No. 2 foundry is quoted as follows in the leading centers: Pittsburg, $14.40; valley furnaces, $13.50; Philadelphia, standard, $13.50; Birmingham, southern, $10; Chicago, $15; Cleveland, $13.75 and Buffalo, $13.25. Steelmaking irons, particularly basic, show further declines and sales of the latter grade have been made at slightly less than $13.90, Pittsburg; Bessemer iron is quoted at $15.90, Pittsburg, and Lake Superior charcoal is unchanged at $16.50, Chicago. Pig iron production during the first half of 1911, according to figures compiled by *The Iron Trade Review*, amounted to 11,411,405 tons, which is at the rate of 23,000,000 tons for the year. The total output of coke and anthracite pig iron in June was 1,781,406 tons, compared with 1,871,388 tons in May, a loss of 89,982 tons. Among the non-ferrous metals, copper continues weak and is quoted at 12.75 cents and 12.55 cents for lake and electrolytic, respectively, in large lots, New York. Heavy arrivals of tin have resulted in slightly lower prices and sales have been made at 42 cents, New York. Lead is held at 4.50 cents, New York, and 4.40 cents, St. Louis, and spelter is quoted at 5.75 cents, New York, and 5.57½ cents St. Louis. Antimony continues to decline, Hallett's having recently sold down to 8 cents and Cookson's is offered at 8.50 cents.

The Lawlor Improved Jarring Molding Machine Co., Pittsburg, has moved its headquarters, formerly located in the Century building, to the offices of the Union Foundry Co., Carson street, where its line of jarring and squeezing machines is being manufactured.

Death of H. F. Frohman

Harry F. Frohman, treasurer and general manager of the S. Obermayer Co., Cincinnati, died in the offices of that company on the morning of July 5. He had been in ill health for several months, but his death was due directly to prostration brought on by the terrific heat that prevailed during the first week in July. On the morning of his death, Mr. Frohman went to his office as usual and complaining of the excessive heat retired to rest in a quiet part of the office. In a very short time his prostration became acute and he passed away within an hour and before the services of a physician could be obtained.

Throughout his career Mr. Frohman took an active part in the advancement of the foundry industry and to his efforts can be traced the introduction and development of many labor-saving devices and supplies that have effected great economies in foundry practice. Although only 42 years of age at the time of his death, Mr. Frohman devoted practically 25 years of his life to the foundry supply and equipment business. He was first employed in 1886 as an office boy by Simon Obermayer, who originally established the S. Obermayer Co. As a result of his persistent application he was gradually advanced until he held the position of secretary and treasurer with the original company. When the firm was reorganized in 1901, Mr. Frohman was elected treasurer and general manager and held that position until his death. Under his management the S. Obermayer Co. was developed to its present prominent position in the foundry supply and equipment field. Throughout the country and particularly in Pittsburg and Chicago, Mr. Frohman was widely known in the foundry trade.

H. F. FROHMAN

Mr. Frohman was born Dec. 8, 1868, and was a graduate from the Hughes high school, Cincinnati. He took an active interest in the public affairs of Cincinnati and was a member of the Business Men's Club and the Cincinnati chamber of commerce. He was also a thirty-second degree Mason. Mr. Frohman's loss is keenly felt, not only by his many friends, but by the whole circle of men engaged in foundry work.

Personal

Cornelius T. Myers, formerly connected with the Wisconsin Engine Co., Corliss, Wis., as assistant secretary and treasurer, has become identified with the General Motors Co., Detroit.

Theodore Kauffman, formerly manager of the Chicago plant of the S. Obermayer Co., Cincinnati, has been appointed general manager of that company, with headquarters in Cincinnati, to succeed the late Harry F. Frohman. S. T. Johnston succeeds Mr. Kauffman as manager of the Chicago office.

E. Killing, of the E. Killing's Molding Machine Works, Davenport, Ia., has just returned from an extended trip through Europe. While abroad, Mr. Killing established agencies for his extensive line of molding machines in Germany, Russia, Austria - Hungary, Sweden, Norway, Finland and Denmark.

Book Reviews

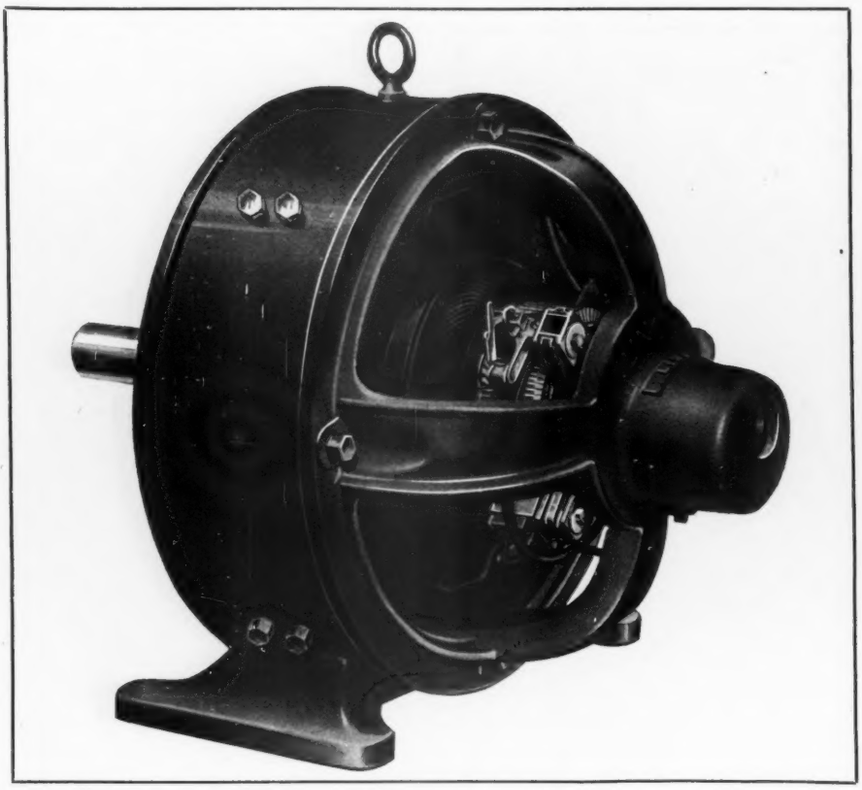
The Iron Ores of Lake Superior, by Crowell and Murray, chemists and metallurgists; 6 x 9 inches; 186 pages Supplied by THE FOUNDRY for $3.50.

This exceedingly interesting volume contains facts of general and particular interest relating to mining and shipping of the ore and location of the principal mines of the various Lake Superior iron ore regions. The book is the result of careful research made by Crowell and Murray, chemists and metallurgists, with principal offices in Cleveland and other branches in Buffalo, Erie and at other lake ports. A history of the Lake Superior iron ore industry is given and this is followed by chapters on the complex geography of the ranges, descriptions of each with idealized cross-sections of the deposits, mineralogy, mining methods, transportation, with tables of freight rates from 1885 by ranges and ports, specifications describing methods of analysis and the

manner of figuring prices from analysis, with tables showing ore price since 1855, and 134 pages of detailed description of the principal mines of the various ranges, including mines in Canada, just across the lakes. These descriptions include accurate location, analyses, yearly shipments, manner of mining and ore deposits. This is the first attempt to give in a concise and permanent form this information, which has heretofore been scattered through various publications and has never before been available in one volume.

An Electric Arc Welder

For the purpose of patching defective castings, burning off risers and similar work in steel foundries, the

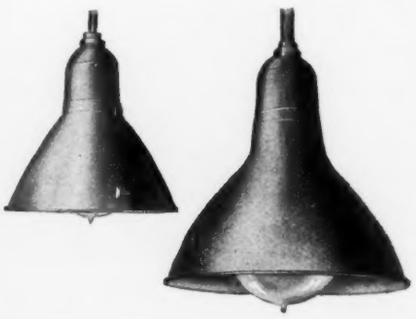


LINCOLN ELECTRIC ARC WELDER

Lincoln Electric Co., Cleveland, has developed a new type of transforming device shown in the accompanying illustration. It is fundamentally a variable voltage machine, the voltage at the arc depending entirely upon the amount of current flowing and this voltage at the arc can be set for any value which the operator may desire. By the use of this welder, the length of the arc determines entirely the amount of current flowing and by varying the length of the arc the amount of current which is flowing can be automatically varied. There is no ohmic resistance used on the usual work and since there is only one machine and one commutator, the no-load losses are very small compared with what they would be in the case of a motor generator set. The enormous saving in current is indicated by the fact that from 80 to 85 per cent of the power taken from the line is found in the arc when the machine is in operation. The machine is furnished with a panel board, which can be mounted directly on the welder. On this board are mounted an ammeter, main switch, arc switch and field regulator and the entire weight of the outfit is only 1,500 pounds. It is portable and can be taken to any part of the shop on a truck. The machine can also be equipped with a push button device so that it may be started or stopped by the operator without being compelled to go into the room where the machine is located. In this way the operator can shut down the welder if it is not to be used for any length of time. If the supply current is alternating it becomes necessary to use a motor generator set and even in this case the use of any resistance has been entirely eliminated so that the efficiency of the outfit is extremely high and the regulation is equally as good as when the supply current is direct. In addition to repairing defective steel castings, burning off risers, etc., the welder can be used for burning holes in boiler plate and other similar work. With the usual machine adapted for steel foundry work it is possible to obtain any current from 50 to 500 amperes at any voltage that the operator may require. Direct-current machines are built in three sizes of 400, 500 and 600 maximum arc amperes and three alternating current sizes are also built, 25 to 60 cycles, two or three-phase, of 400, 500 and 600 maximum arc amperes.

Universal Holder Socket

The Adams-Bagnall Electric Co., Cleveland, manufacturer of arc lamps, electric fans, etc, is now manufacturing a line of universal holder sockets known by the trade name of "Abolites." This holder socket is a unit which takes the place of socket, shade holder, and at the same time performs the function of a fixture for a single unit illumination. To obtain scientific illumination, it has always been necessary to secure proper relations between the lamp and the reflecting surface. On account of the different lengths of bases in some types of electric lamps, it has been found necessary to attach several kinds of separable holders to a regulation socket. The reflector in turn was suspended from the holder. The primary construction characteristic of the universal holder socket is the provision of a metal support for a reflector to replace variable holders.



SIXTY AND 250-WATT, BOWL "ABOLITES"

The complete holder socket for industrial purposes is made of two parts, including the universal holder socket and a scientifically designed steel reflector. In the accompanying illustrations are shown 60 and 250-watt, bowl "Abolites." The use of this holder eliminates all separable holders and one socket is universal for all lamps from 25 to 500 watts, inclusive. All weight is suspended from the holder socket and the reflector can be removed for cleaning without breaking any wire connections or disturbing the holder socket. Intensive and extensive illumination is obtained with the same holder socket by merely

changing the positioning device. In connection with the introduction of this line, the Adams-Bagnall Electric Co. has established a department of efficiency engineering for the purpose of studying industrial conditions and for co-operating with industrial managers in bringing their illumination to a plane where labor efficiency and factory output will be greatly increased.

British Foundrymen's Convention

The annual convention of the British Foundrymen's Association will be held in Glasgow, Scotland, during the week of Aug. 7. Professional sessions will be held on Tuesday and Wednesday, while Thursday has been set apart for a pleasure trip. Percy Longmuir has been nominated by the council for re-election as president. A large number of papers will be presented, including a discussion of the "Shrinkage of Light Castings", by Mr. McGowan; "Carbon in Cast Iron", by R. Buchanan; "Foundry Irons", by H. Pilkington, and "Art as Expressed in Castings", by Mr. Bagnall. The works to be visited include those of J. & G. Weir, Ltd., and the locomotive works of the North British railroad. The association now has a total membership of considerably over 700.

Sodium

The metal, sodium, is silvery white in appearance when freshly cut, but rapidly tarnishes, first to a coppery hue, then white, and ultimately is resolved into a powder. For this reason the metal is shipped in cans, and as it is of wax-like softness, it may be dug out with a knife when used. About 2,000 tons are annually preduced in the United States. It is reduced in an electric furnace of special form and is tapped out into large ladles from time to time, the surface of the molten metal being covered with a layer of paraffine to protect it from oxidation. From the ladles it is poured into the cans in which it is shipped.

Trade Notes

A. P. Munning and W. L. Loeb have organized the Munning-Loeb Co., with main offices and works at Matawan, N. J. This concern will engage in the design and manufacture of electro-plating and buffing equipment and supplies. The plant operated by this concern is well equipped to meet the prompt requirements of the electro-plating trade.

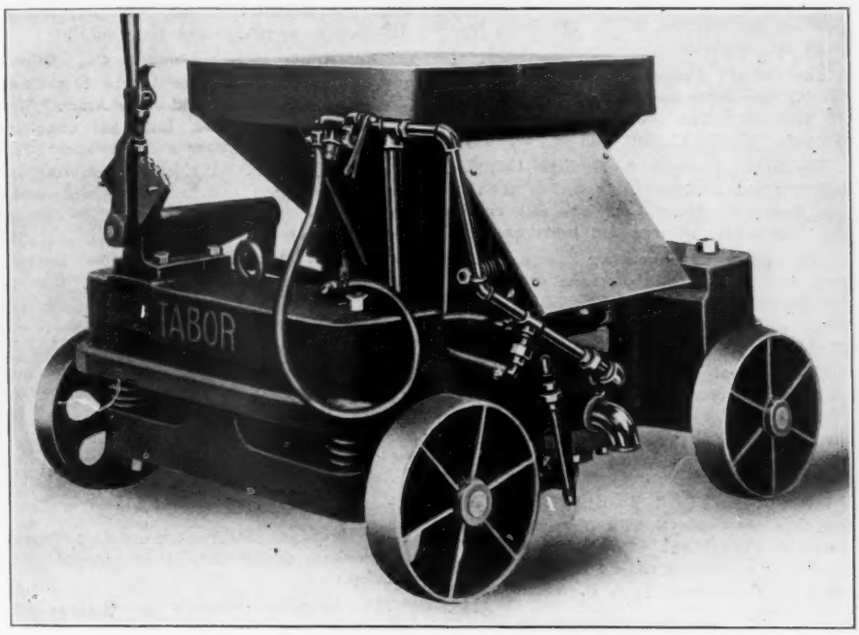
In an artistic little booklet treating of the origin, characteristics and uses of tin, issued by the Lumen Bearing Co., Buffalo, it is stated that the specific gravity of tin is 7.298 and its melting point 450 degrees Fahr. The metal is obtained from tin stone, which is oxide of tin, and is found in large quantities in the Malay Peninsula and the Dutch East Indies. The world's total consumption in 1910 is placed at 214,518,000 pounds, of which the United States consumed about 40 per cent.

The Sprague Electric Works announces the appointment of Frank W. Hall, formerly manager of its Philadelphia office, as manager of hoist sales. Mr. Hall will be located at the New York office of this concern and James A. Clifford, formerly manager of the Baltimore office, has been appointed manager of the Philadelphia office, the Baltimore office continuing under the supervision of Mr. Clifford, but as a subsidiary to the Philadelphia office with Henry S. Patterson in charge.

The Frodair Iron & Steel Co., Ltd., London (Eng.), has issued a 126-page handbook for iron founders, which contains considerable interesting information on English gray iron foundry practice. The effect of the different elements in iron is discussed and the addition of steel to cast iron in the cupola is considered at length. A number of mixtures are also included in which English brands of pig iron are specified, and the various tables which conclude the work complete a valuable handbook for gray iron foundrymen.

Portable Shockless Jarring Machine

For comparatively small work, and particularly for core room use, the Tabor Mfg. Co., Philadelphia, is now building a portable, shockless, jar-ramming molding machine, as illustrated herewith. This machine operates in precisely the same way as the large shockless jarring machine built by this company, which is mounted on a cylinder base, but in this case the entire load is carried on four-wheel trucks through the intervention of four springs, two of which are shown in this illustration. A slight amount of friction between the trucks and the anvil serves to bring the anvil quickly to rest and removes any tendency to oscillate while jarring. The machine complete, as shown, weighs 2,000 pounds and it can be used for jar-ramming half molds weighing about 1,000 pounds.



PORTABLE SHOCKLESS JARRING MACHINE

Trade Publications

WOOD-WORKING MACHINERY. — The 1912 catalog, recently issued by the Crescent Machine Co., Leetonia, O., illustrates and describes the extensive line of wood-working machinery manufactured by this concern. Additional tools included in this issue are band saw guards, a post borer and a 30-inch planer. The line of pattern shop equipment shown is extensive and consists of all of the requisite tools for the making of patterns and core boxes. The catalog is handsomely illustrated and the various tools are described in detail.

GENERATING OXYGEN AND HYDROGEN.—In a 16-page booklet, issued by the International Oxygen Co., 68 Nassau street, New York City, its system of generating oxy-

gen and hydrogen for cutting, welding and other purposes, is described in detail. A view of the company's plant at Waverly Park, N. J., is given as well as interior views of the works, showing installations of these generators. This equipment enables the manufacturer to produce pure oxygen and hydrogen on his own premises and the generators can be installed in small or large units to meet any requirements.

ALUNDUM PRODUCTS.—Alundum refractories, manufactured by the Norton Co., Worcester, Mass., are illustrated and described in a recently issued 32-page booklet. The melting point of this material is approximately 2,100 degrees Cent., and in addition it possesses a high thermal conductivity. Having a comparatively low thermal coefficient, it is not affected greatly by changes in temperature. The material can be used to advantage for the refractory parts of small electric furnaces, for muffles, for crucibles for general laboratory use, and for electric furnace work. In addition to the physical refractory properties of alundum, it has the additional advantage of being sufficiently pure for filtering and numerous filtering devices are made for laboratory and experimental work.

General Industrial Notes

The Omaska Tractor Mfg. & Foundry Co., St. Louis, has changed its name to the Downs Tractor Co.

The United States Motor Castings Co., Detroit, has been incorporated with a capital of $5,000 to engage in the manufacture of automobile castings.

The American Foundry & Construction Co., Pittsburg, has practically completed the erection of an addition, 50 x 200 feet, to its plant at Hazelwood.

The West Tacoma Steel Co., Tacoma, Wash., has been incorporated with a capital of $500,000. The incorporators are M. E. Gunston, W. R. Flaskett and R. W. Taylor.

The Olive Foundry & Machine Co., Ironton, O., has changed its name to the Ironton Punch & Shear Co., and will continue the manufacture of iron and brass castings.

The Canton Castings Co., Canton, O., has been incorporated with a capital of $250,000. The incorporators are L. E. Shull, W. A. Strayer, L. A. Buchanan, O. F. Kwiatt and A. J. Hill.

The National Foundry Co., Detroit, Mich., has been incorporated with a capital of $25,000. The incorporators are John B. Fleming, Harry A. Crawford, Paul Weadock, Ernest C. Smoots and James W. Martin, all of Detroit.

The Kultger Nichol Foundry Co., Chicago, has been incorporated with a capital of $10,000 and will engage in the operation of a foundry and machine shop. The incorporators are John D. Kultger, John G. Nichol and N. J. Johnson.

The Warren Steel Casting Co., St. Louis, announces the completion of its crucible steel casting foundry. This concern will devote special attention to small high grade steel castings for automobiles and other machinery requiring high class work.

The Langer Auto Castings & Foundry Co., Chicago, has been incorporated with a capital of $7,000 to engage in the manufacture of iron, brass and aluminum castings. The incorporators are Conrad P. J. Langer, Joseph Van Craebebbroech and John Holland.

The McDonald Bros. Machine & Foundry Co., Gage, Okla., has been incorporated with a capital of $7,000 and will engage in the manufacture of gray iron, brass and aluminum castings. The incorporators are W. H. McDonald, J. F. McDonald, I. O. McCollough, R. R. Sherwood, and others.

The Electric City Foundry Co., Schenectady, N. Y., manufacturer of iron, brass and aluminum castings, has been incorporated to take over the plant formerly operated by the Mohawk Foundry Co. The officers of the company are A. F. Shaffer, president; C. F. Buhrmaster, vice president and treasurer, and E. J. Morrow, secretary and general manager.

The Vesta Gas Range & Mfg. Co., Chattanooga, Tenn., recently incorporated with a capital of $100,000, has taken over and will remodel the plant formerly occupied by the Chattanooga Stove Co. The foundry is of brick construction, 60 x 225 feet, and will be used for the manufacture of gas ranges, steel ranges and cook stoves. The officers of the company are C. C. Huntington, president; E. Schmalzried, vice president, and M. H. Coffey, secretary and treasurer.

The Armor Steel Foundry Co., Winton place, Cincinnati, successor to the Steel Foundry Co., Cincinnati, and the Armor Steel Foundry Co., Matthews, Ind., has completed the erection of additions and the installations of new equipment. A sideblow converter and cupola have been installed which will enable the company to manufacture small castings for automobile and tool manufacturers. The Armor Steel Foundry Co. is now equipped to manufacture castings up to 10 tons in weight by the basic or acid open-hearth and converter steel processes. In addition, this company will manufacture steel castings of any desired alloy, such as manganese, chrome, titanium and nickel and is also prepared to furnish castings, surface hardened by the Gebhard process.

New Construction.

The Michigan Steel Castings Co., Detroit, contemplates the erection of an addition to its foundry.

The American Foundry & Machine Co., Hamilton, O., will erect a reinforced concrete foundry, 100 x 118 feet.

The Hart-Parr Co., Charles City, Ia., will erect an addition to its iron foundry, consisting of two wings, each 30 x 270 feet.

The Newark Plaster Co., Newark, N. J., will erect a one-story foundry, 80 x 105 feet, on Passaic avenue. The building will be of brick construction.

The Peck-Williamson Heating Co., Oakley, Cincinnati, O., recently merged with the Federal Heater Co., will erect extensive additions to its foundry.

The Massey-Harris Co., manufacturer of agricultural implements, contemplates the erection of a three-story addition, 60 x 180 feet, to its plant at Brantford, Ont.

The Root & Vandervoort Engineering Co., East Moline, Ill., has under construction, an addition to its gray iron foundry, 100 x 150 feet, which will greatly increase its present facilities.

The Peck, Stow & Wilcox Co. will erect a machine shop, 50 x 300 feet, and a foundry, 60 x 210 feet, with annex, 30 x 112 feet, in addition to several other buildings, at Southington, Conn.

The Connor Foundry Co., Grand Rapids, Mich., has been incorporated with a capital of $15,000 to engage in the manufacture of gray iron, brass and aluminum castings. A foundry, 48 x 100 feet, is now in course of construction.

The American Foundry & Supply Co., Asheville, N. C., successor to the Sternberg Foundry & Supply Co., will erect a foundry, 70 x 70 feet, in addition to a pattern shop, 40 x 50 feet, and a machine shop and storage department, 40 x 200 feet.

The Universal Machine Co., Toledo, O., which recently took over the plant of the Standard Machine Co., Bowling Green, O., is erecting the following additions: Machine shop, 60 x 120 feet; foundry, 55 x 100 feet; pattern shop, 30 x 40 feet, and blacksmith shop, 25 x 40 feet. The company will remove its plant from Toledo to Bowling Green about Oct. 1.

The business of the Central Iron Foundry, Salem, Mass., formerly conducted by C. H. Learock, has been sold to Jas. A. Leonard, formerly assistant foundry foreman with the Turner Tanning Machinery Co., Peabody, Mass. Mr. Leonard contemplates building an addition to his foundry in the near future to accommodate 20 additional molders. Mr. Learock, the retiring owner, has gone to California for his health.

The Strong Steel Foundry Co., Buffalo, has purchased 10 acres of land in the Elmwood-Hertel avenue district, upon which it will shortly erect a new plant for the manufacture of high grade steel castings. This concern has recently taken up the manufacture of special steel castings, such as vanadium, chrome, nickel, titanium and manganese. The officers of the company are as follows: O. H. P. Champlin, president and treasurer; A. A. Berrick, vice president, and James E. Keller, secretary.

The Cadillac Motor Car Co., Detroit, contemplates the erection of extensive additions to its present plant. This concern has recently acquired a large tract of land adjoining its Trombly avenue plant. The new buildings include an addition to the iron foundry, 72 x 230 feet, a brass foundry, 50 x 140 feet and a three-story manufacturing building, 60 x 270 feet. Two additional stories, 60 x 428 feet and 60 x 76 feet, respectively, will be added to its Fort street plant and concrete sand bins, 50 x 288 feet, will also be erected.

Hetherington & Berner, Indianapolis, Ind., have under construction a foundry, 180 x 45 feet, with a span the entire length of the building, to be used as a molding floor and served by a 15-ton electric crane, in addition to a bay, 20 x 180 feet, to be used as a cleaning room, office, core room, etc. The machine shop will be 220 x 85 feet and will be served by an electric traveling crane running the entire length of the building. The buildings are of brick, steel and concrete construction and the plant will be placed in full operation about Oct. 1.

Among the Brass Founders.

The Adams & Westlake Co., manufacturers of brass beds, car and ship hardware, etc., has purchased property at Twenty-second and Ontario streets, Philadelphia, upon which it will shortly erect a new plant.

The Salem Brass Foundry Co., Salem, Mass., Geo. Godsland, proprietor, will erect a new foundry on the outskirts of Salem in the immediate future, having recently purchased a plot of ground for this purpose. The present plant will be torn down to make room for trackage of the B. & M. railroad.

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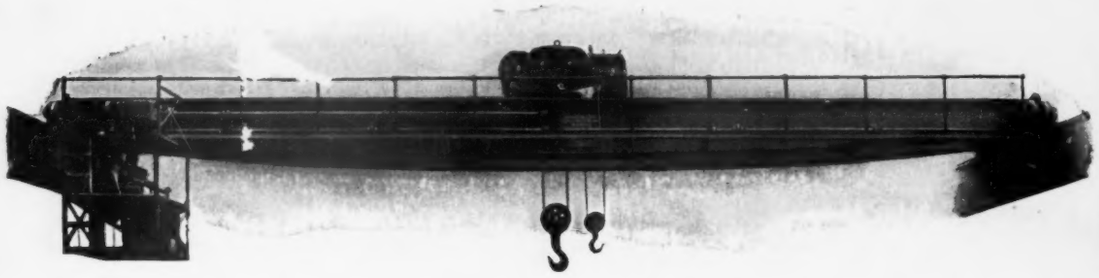

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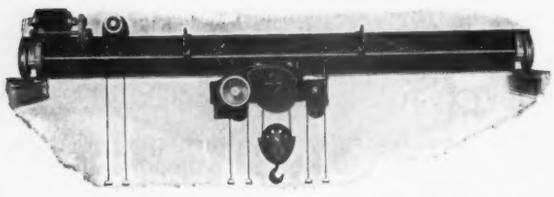

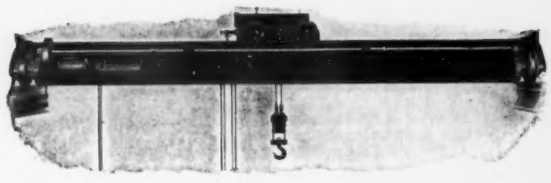

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